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COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC.

Vol. XIV JANUARY, 1909 No. 1

COMPRESSED AIR KILLING WEEDS

The half-tone Fig 1 shows in operation one of a comparatively new class of agricultural implements promising valuable results to the farmer. It is for the eradication or control of weeds in the growing crop by spraying with certain chemicals which are said to have a discriminative effect, destroying the weeds without injuring the growing crop. That such a result is actually accomplished seems to be attested by the photo reproduced in Fig. 2 and issued from the Agricultural Experiment Station of Cornell University. This field was infested with wild mustard; the area at the right was sprayed and that at the left was not, with the result shown. On the sprayed area the wild mustard has absolutely disappeared while the grain is developing to perfect maturity.

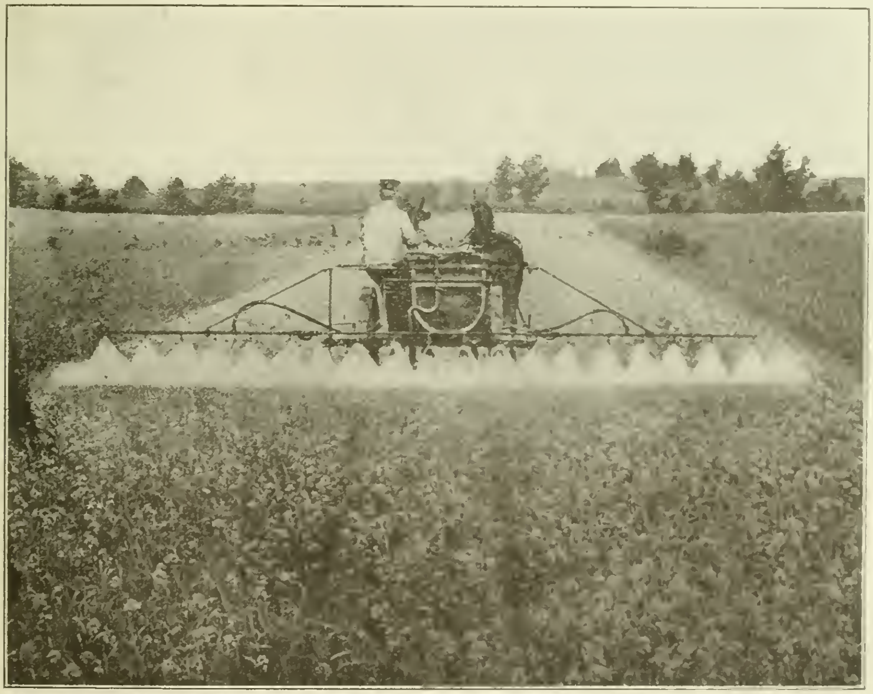

FIG. 1.—KILLING THE WEEDS.

The chemical used in this case was sulphate of iron, and Fig. 1 shows the spraying operation. If there should be any suspicion that the jets shown are exaggerated we are not responsible, as this half-tone is reproduced from *Farm Implements*. It is to be understood, however, that the nozzles are of special design and that a pressure of 100 pounds or so is constantly maintained upon the liquid in the tank. The force imparted by this pressure is said to be very necessary in securing the desired effect. The tank holds from 120 to 150 gallons of the liquid, and the required pressure is maintained by an air compressing pump operated by power from the wheels. These machines are now made by a number of builders with differences of design which it is not necessary to go into. Hand sprayers also are made carrying three or four gallons, they also using compressed air to give force to the jet.

GAYLEY'S INVENTION OF THE DRY BLAST*

By Dr. R. W. Raymond, New York.

The immense commercial value of the Gayley dry blast process has been established beyond controversy. The testimonial of practical blast furnace managers, on both sides of the Atlantic, agrees that it reduces the cost of pig iron about $1 per ton; but from the same testimony it appears that this direct economy does not by any means cover its commercial advantages; in fact, that under present conditions frequently encountered in practice it presents other benefits, of even greater immediate financial importance. To this point I shall recur in a later part of the present paper.

The history of the reception given to this invention, especially on the other side of the Atlantic, has repeated an experience familiar to American engineers. First, the reports of our practice were rejected as theoretically impossible, according to generally accepted notions and formulas; then the figures were reluctantly accepted; and finally the attempt has been made to explain theoretically how they could have been obtained. As to the Gayley dry blast, we Americans have been for several years in the last stage of this discussion, and the rest of the professional world is rapidly coming to it.

Meanwhile, the remark has been repeatedly made, that, whatever Mr. Gayley's process may turn out to be worth, it was not an invention on his part, but simply the energetic and persevering execution of a procedure already proposed by others. This question I wish to discuss in the present paper—What did Mr. Gayley invent?

THE NATURE OF THE INVENTION.

Realizing that this is not the place for a detailed argument on an issue of patent law, I shall not undertake to quote and criticise the publications prior to Mr. Gayley's first patents. It may be admitted, without such critical analysis, that the possible advantages of removing moisture from the air forced into an iron blast furnace were recognized and talked about 100 years ago, and again 50 years ago; that methods and apparatus for cooling air (and incidentally precipitating moisture from it) were known before Mr. Gayley's invention; and that, in one case at least, a system of cooling the blast for a converter had been actually patented. All these prior prophecies and proposals might be shown in detail to be impracticable, defective or visionary; but it is not my present purpose to discuss them. The fact remains that after they had all died out to the last echo, and after the object they sought had been pronounced by high scientific authorities, with the general consent of technical experts, economically unattainable, Mr. Gayley went ahead and did the thing.

This alone might not be conclusive as to his claims, since mere energy and perseverance, however meritorious, do not constitute invention. But this is not all. The significant fact must be added that, after beginning, with all the light that previous investigation and invention could give him, his attempt to carry out the "well-known" operation, Mr. Gayley spent six years in costly experiments before he found out how to do it. This certainly raises a strong presumption that, during those six years, Mr. Gayley discovered something not previously known; and it is that discovery which I wish to define.

All previous plans or suggestions for removing moisture from the blast by reducing its temperature have two features in common:

1. Following the analogy furnished by the natural precipitation of dew, they assume that moisture can be effectively removed from the blast in proportion to the reduction of its temperature to successively lower dew points.

2. They assume that this operation would be metallurgically advantageous in proportion

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*A paper read at the meeting of the American Institute of Mining Engineers, at Chattanooga, Tenn., October 2, 1908.

to the extent to which moisture was thus removed. Considering the objectionable effect of such moisture to be a direct function of its amount, they all infer that removing part of the moisture would to that extent remove part of the evil, and that the benefit thus realized would be positive, even if it were but partial.

The first of these assumptions is based upon an incomplete conception of the analogy of nature. Closer observation should have shown these theoretical inventors that the lowering of the temperature of the atmosphere below its dew point does not produce the deposition of dew, except in a quiet atmosphere, because wind prevents the fall of dew and drives it away as fog. Moreover, all the inventions for taking moisture out of air by cooling it deal with bodies of air practically at rest. Nobody before Mr. Gayley had attacked the problem of taking the moisture out of a hurricane in that way; and everybody who had talked, however vaguely, of doing something of the kind with the blast for a furnace had overlooked the circumstance that simply segregating the moisture, by such means, as a mist, and then letting the mist be blown into the furnace, would secure no metallurgical benefit whatever.

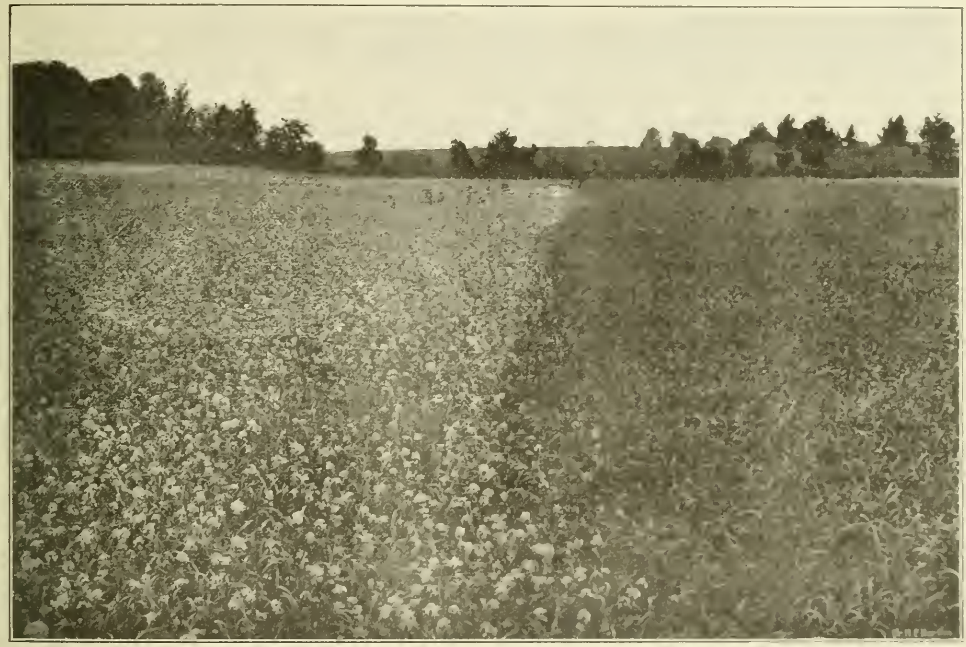

FIG. II.—WEEDS FLOURISHING. WEEDS KILLED.

WHAT MR. GAYLEY DISCOVERED.

By years of patient experiment Mr. Gayley discovered, and was the first to declare, that if the reduction of temperature were carried to or below the freezing point of water, the ice or snow thus formed could be precipitated as well as segregated; that (with proper proportions of apparatus) it could be practically caught and held, so as to permit a blast free from suspended mist or fog to go forward into the furnace. The amount of aqueous vapor still held in the air would depend, of course, upon its temperature. There would be less of it at 10 degrees below freezing point than at that point. But this small difference has little practical significance. The main point is, that unless the moisture be not only segregated by cooling, but actually solidified, its approximately complete deposition from a rapidly moving current cannot be effected. Practically, therefore, the effect of going below the freezing point is to make sure that that point has been effectively reached in all parts of the current.

With regard to the second assumption above stated, it follows from what has been said already that no reliable metallurgical advantage can b secured by cooling the blast to any temperature short of the freezing point. For under such circumstances, not only might moisture thus segregated be carried onward as mist, but the possible precipitation of a part of it as rain, en route, would introduce a new and serious evil—the evil of uncertainty. This point deserves special discussion.

CERTAINTY A NECESSARY ELEMENT OF AN ART.

The significance of certainty as a necessary element of any real industrial art has been often overlooked. To such loose logic we owe much fascinating but misleading rhetorical celebration of the "lost arts" of the ancients. In spite of the eloquence with which these "lost arts" have been extolled by orators and amateurs, I have been brought by much patient study to the conviction that (as a general rule, at least) no real arts have been lost. For an art is a process which arrives with reasonable certainty, by the intelligent use of definite means, at a desired and foreseen result. This proposition may be made clearer by illustrations. For instance:

Certain ancient tribes are said to have heated iron ore and wood or charcoal together in rude hearths, with the aid of the wind blowing across a mountain top, or of a primitive bellows, supplying an artificial wind, producing thus a half fused conglomerate, out of which could be selected pieces of true steel—indeed, of tool steel or razor steel—of exceptionally high quality. But the assertion that these ancient experimenters had the art of making steel is not justified by any such stories, however authentic. To combine blindly the materials and forces furnished by nature, and then to overhaul the result, seeking for fortunately valuable products, is not to practice an art. Such vague experimenting may be the beginning, out of which, with greater knowledge and the growth of conscious skill, an art may come; but an art it is not. For an art demands the intelligent use of definite means for a definite end.

On the other hand, it is not easy to say at what point a primitive and empirical procedure attains the rank of an art; and it is not necessary for my present purpose to fix that point. The much more important proposition which I wish to emphasize is this—that every industrial process involves the two elements of ignorant dependence upon natural conditions and intelligent control of such conditions, and that the degree of perfection attained by a given art is the degree in which the former element has been superseded by the latter. In practice we try to make a specified product by a given process; yet often, in spite of all our scientific or traditional precautions, a part of our output fails to meet the specifications imposed upon us, and must be rejected; so that, in a general way, it is fair to say that the perfection of an art is measured in inverse ratio to the proportion of such "rejections."

CHEMICAL ANALYSIS HAS REVOLUTIONIZED FURNACE PRACTICE.

The progress of our metallurgical arts toward perfection in this respect has been largely due to the exact determination of the composition of our raw materials. We can all remember when American iron and steel works began to employ chemists of their own, and to determine by chemical analysis not only the character of their products, but also the nature of their ores and fluxes. The result has been a revolutionary transformation of our blast furnace practice. The old "founder," who diagnosed his slag and dosed his furnace accordingly, has disappeared. The superstitious reliance upon this or that brand of ore as a material for this or that brand of iron has gone with him. The chemist dictates the charges and tests the product.

Yet, with all this increase of analytical control, the blast furnace has continued to be, as a great authority once described it, at once the crudest and the most delicate of metallurgical apparatus, subject to inexplicable irregularities, and seemingly obeying whims of its own, beyond the provision or regulation of the most scientific manager.

One reason (and, in my judgment, the chief reason) is that, while we have analyzed ores, fuels and fluxes to the second or third place of decimals, we have practically ignored the composition of the blast which goes into the furnace, although this material constitutes more than half the total weight of the materials charged. This defect in our control of the furnace process has not escaped notice. The effect of varying moisture in the blast has been recognized for 100 years past, especially as between summer and winter, and furnace managers have adjusted burden and blast in a rude way to meet the conditions thus created. But I do not think that the significance of diurnal and even hourly variations of the moisture in the blast was ever fully recognized until Mr. Gayley called attention to it. At all events, he was the first to propose a practical remedy for the evils resulting from such frequent changes.

The nature of these evils deserves here a preliminary word, especially because it affects profoundly the validity of all our theoretical calculations of heat economy, etc.

THE INFLUENCE OF MOISTURE IN THE BLAST.

The influence of moisture in the blast may be summarized, with sufficient accuracy for my present purpose, as consisting of two elements: (1) The effect of a useless constituent, diluting the effective oxygen of the air and absorbing heat in acquiring the temperature of other materials, and (2) the effect of a constituent which, by its dissociation, absorbs heat in the hearth (where heat is most needed), and either, by the recombination of its elements, restores that heat in another part of the furnace (where it is neither needed nor desired), or else, through incomplete recombination (evidenced by the presence of free hydrogen in the furnace gas), fails to restore a part of the heat it has absorbed.

We are accustomed to determine economy of the blast furnace process by means of thermo-chemical equations and heat balances, in which we take account of the composition, temperature, specific heat, heat of combination or separation, etc., of the materials entering the furnace, and the composition and temperature of the materials escaping from it. With due allowance for the incidental loss of heat by conduction and radiation, this method should be accurate, if the data upon which it rests are accurately determined. That it fails to give us a perfect criterion of our practice is due, in my judgment, to the circumstances that it is necessarily based on averages, and assumes these averages to represent uniform conditions; such and such a quantity, pressure and temperature of blast, composition of ore and flux, and quantity and grade of pig iron produced. These data are usually averaged from considerable periods; in fact, the longer the period taken, the stronger the assumption of the trustworthy character of the calculation —an excellent rule for most purposes, since averages eliminate incidental variations. But when incidental variations are directly influential upon technical and commercial economy, it is not to be hastily assumed that they can counteract one another, so that the average result is equivalent to that of uniform conditions. Suppose, for instance, that a certain temporary change in one factor of the process would have an injurious technical or economical effect, and that a subsequent equal change in the contrary direction would likewise have an injurious effect. Evidently the net result would not be fairly represented by calculations based upon the average conditions of the period embracing both changes, and upon the assumption that they canceled and neutralized each other.

THE "HEAT BALANCE" OF THE BLAST FURNACE.

That this supposed case is not imaginary I shall try to show. But first I would point out another defect in our usual method of stating the "heat balance" of the blast furnace. Our estimates of the utilization and the waste of heat may be practically fair enough, so far as the heat requirements of reduction and fusion, and the loss of heat in slag and gases are concerned; but they are seldom based on accurate data as to the grade of the pig iron actually produced. At least, so far as I now recall, the highest degree of accuracy in that respect does not go beyond a recognition of the general distinction between different grades, from foundry to white iron, or of the special heat requirements of pig iron of peculiar chemical composition (as to silicon, sulphur, manganese, etc.).

The statement that a given furnace is "running on" this or that grade of iron, and the use in calculation of the figures appropriate to that grade, seems to be the best that has been achieved in this regard. But a furnace "running on" a particular kind or grade of iron not only may, but in present practice invariably does, produce more or less iron of other grades (sometimes colloquially called "off iron"), the amount of which, sometimes even exceeding 50 per cent. of the total product, may seriously affect the value of our technical calculations of heat economy, if these do not include it as a factor. I offer this suggestion as a partial explanation of the fact that such theoretical calculations do not always furnish a safe criterion of alleged or possible technical economies. The method is scientifically sound, but it is applied to data too roughly determined for such precise mathematical discussion. Many of us have heard of the distinguished engineer, of whom it was said that in "duty trials" of engines he "would carry out to the third decimal place the determination of the weight of the ashes, while he guessed at the amount of coal shoveled into the fireplace." Possibly some such inconsistency may explain the hasty conclusions of some foreign experts that the reported technical economy of Mr. Gayley's process was "simply impossible."

THE COMMERCIAL ECONOMY OF THE PROCESS.

As regards commercial economy, on the other hand, there is no room for doubt or contradiction. If a blast furnace is "running on" (*i. e.,* managed with the purpose of producing) a particular kind of pig iron, and if Mr. Gayley's process will deliver it altogether, or to an unprecedented degree, from the risk of producing incidentally another kind, not called for, and probably not desired or not readily salable at a profit, the commercial value of this insurance is beyond measurement by any technical formula that has been, or could be, constructed. The case presented in Mr. Cook's paper on "Experience with the Gayley Dry Blast at the Warwick Furnaces,"* furnishes a striking illustration of this proposition.

As already observed, the testimony from iron works both in the United States and abroad agrees in declaring that the Gayley process reduces the cost of pig iron about $1 per ton; but this saving, though important, is trivial, compared with the commercial advantage of a more effective control of the operation and product of the furnace. To state the case roughly, the Warwick Iron & Steel Company was caught, with innumerable others, in the financial revulsion of 1907, which stopped for a time the market for pig iron. The company had a profitable contract with solvent customers for iron of a special grade; but the old and almost dilapidated furnace which it had kept in blast for the purposes of that contract was running so irregularly that only half —or less—of its product could be delivered under the contract, and the rest would have to be stored as not immediately salable, and, indeed, as never likely to be salable at a price covering the special expenses incurred for the purpose of producing the special, and more costly, grade of product for which the furnace had been burdened and operated.

Under these circumstances, the interest on the capital represented by the "off iron" would have exceeded the profits on the proportion of special iron delivered under the specifications of the contract; and a prudent manager would have been obliged to accept the unwelcome alternative (adopted, in fact, by most of our American merchant furnaces) of sacrificing his pending contract, blowing out his furnace, and submitting to the loss in general expenses, interest, etc., and the even greater damage caused by the scattering of skilled and trusted workmen and the inability to take immediate advantage of a general revival of business, or of a sudden special opportunity for a local resumption of work. These disastrous effects of a suspension of operations are, as I need scarcely say, those most dreaded by technical managers, since, besides their direct financial results, they involve the immeasurable anxiety and responsibility of efficient reorganization.

Fortunately for the Warwick Company it had just completed the installation of an expensive plant for the Gayley process; and the operation of this plant, under all the disadvantages of new and untried apparatus, inexperience of both manager and workmen, and dilapidated condition of the furnace then in blast, enabled the company to raise the proportion of its immediately and profitable marketable product from below 50 to above 80 per cent.; to fill its pending contract; and to realize, instead of industrial demoralization and financial loss, a substantial profit from continued operations. Indeed, it is no secret that, through the total gains of this campaign, the entire cost of the installation of the Gayley system, including the sum paid for the patent right, was repaid in a few months, though the certified saving of $1 per ton in the average cost of pig iron would not by any means have accomplished that result in so short a time.

The situation above described is one which any manager of a "merchant" blast furnace (*i. e.,* a furnace selling its product to outside

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**Bi-Monthly Bulletin*, No. 24, November, 1908, p. 917.

customers) may at any time encounter. But it carries a meaning also for establishments like the works connected with the United States Steel Corporation and other great concerns, which have a use for the "off iron" produced by their blast furnaces. For such "off iron" could be manufactured at smaller expense than when it is turned out as an unwelcome by-product from a furnace charged and operated, at extra cost, to yield a more valuable product. In short, every blast furnace manager knows that both technical and commercial economy, as well as relief from personal anxiety, would be secured if he could only be sure of making what he is trying to make.

ADDS A FINAL ELEMENT OF CERTAINTY TO BLAST FURNACE CONTROL.

This brings us back to the inquiry: What is the bearing of Mr. Gayley's invention upon this desirable element of certainty, through complete and intelligent control, in the operation of the blast furnace?

As I have already observed, we have sought to secure such certainty through minute analyses of all the raw materials, etc., except the air of the blast, which weighs more than all the rest put together. But when we come to consider this element, we perceive at once that it cannot be usefully analyzed like ore, flux or fuel. We cannot determine its composition and then store it until we wish to use it; and if we could analyze it as it enters our blowing engines our knowledge would come too late to permit any effective action on our part, based upon such information. If we would attain that certainty of control which constitutes the perfection of an art, we cannot treat the air of the blast as we do all the other elements of the charge, which we regard as variables to the character of which we adjust our practice. The air, most variable of all, cannot be thus dealt with. We must make it practically a constant. Mr. Gayley has shown us that the only way to do this is to freeze the moisture out of it. No attempts at vague amelioration by partial measures will meet the case. What we want is, first, to know just what we are putting into the furnace through the blast, and, second, how we can continue to do that particular thing practically without variation.

Mr. Gayley, after years of costly experiment, has shown us for the first time how to attain this object; and I am not surprised that leading ironmasters in this country and abroad have recognized his invention as the greatest advance in blast furnace practice since the introduction of the hot blast by Neilson. It is scarcely too much to say that this invention, completing our mastery of conditions previously uncontrollable, has elevated the manufacture of pig iron from the category of processes which are partly art and partly accident to that of the true arts, which may be practiced with approximate scientific certainty.

HIGH AND LOW AIR PRESSURE FOR SAND BLAST

Mr. James M. Belton has begun in *The Foundry* a valuable series of papers upon "The Sand Blast in the Foundry." From the first instalment we reproduce the following discussion of the relative advantages and disadvantages of high and low pressures.

Most sand blasts are operated under a moderate air pressure, not exceeding 30 pounds, but in some of the later types an air pressure of 80 to 100 pounds is used, principally because that pressure is usually installed for the operating of pneumatic tools, and it does not seem desirable to use a reducing valve and cut down the pressure.

A high air pressure implies the use of a nozzle of small diameter, otherwise the consumption of air would be enormous, and few air plants could meet the demand. The disadvantage of the small nozzle is that it limits very materially the sand that can be used, as only a moderately fine grade will pass through a ¼-inch nozzle, which is generally used with high pressures, without obstructing it, and it is often desirable to use large sand or fine gravel for cleaning. The cost of maintaining the pressure is naturally greater for a given quantity at a high pressure than for low, and although the discharge of the nozzle may not be as much from the larger one under a lower pressure, which will do the same work, the net cost of operation is about the same in either case. The track or cleaning path of the high pressure jet is not as broad as the low pressure and less surface is covered per minute. The sand is badly shattered and pulverized under the high pressure and cannot be used as often as when worked under low pressure. More dust is formed, and an examination of the casting under a powerful magnifying glass will show that the surface or skin is indented by the particles of sand, and that some particles are imbedded in the casting, giving it a fine coating of silica which is destructive to cutting tools. On this account a low air pressure is required for aluminum, brass, bronze, and other castings of the tin and copper alloys.

It requires 15.94 horsepower to compress 100 cubic feet of air from atmosphere to 80 pounds pressure, with one-stage compression and 6.28 horsepower to compress the same quantity to 20 pounds pressure. A ¼-inch nozzle under 80 pounds pressure will require 85 cubic feet of free air per minute or 0.85 × 15.94 = 13.55 horsepower, and if we reduce from 80 pounds to 20 pounds we can use a ⅜-inch nozzle requiring 69 cubic feet of free air, and 0.69 × 15.94 = 10.99 horsepower. A ½-inch nozzle, which will give a quicker cleaning, will require, when the pressure is reduced from 80 pounds to 20 pounds, 123 cubic feet of free air per minute, and 1.23 × 15.94 = 19.60 horsepower.

There is no special advantage in cleaning with high pressures, and as they limit the range of the sand blast, they are not entirely desirable. If a separate compressor is not available for sand blasting, the pressure may be cut down by means of a good pressure reducing valve, which has the advantage of allowing any change in the pressure as desired, and the disadvantage of requiring the air to be compressed first to a higher pressure than that at which it is used, implying an additional expense for power. Low pressures do as good work, cost less to produce, allow the use of larger nozzles, cover a greater surface in a given time, are easier upon the operator and are less dangerous and generally to be recommended.

DIFFERENT PRESSURES FOR DIFFERENT CASTINGS.

Excellent work can be done in cleaning medium and heavy grade, iron castings under 15 to 20 pounds air pressure; aluminum castings, 10 to 15 pounds, brass, composition or other bronze castings, 15 to 20 pounds, steel castings, 35 to 75 pounds, depending upon whether green or dried sand molds are used and the tenacity of the adhering burnt sand; generally 35 pounds will be sufficient to give a thorough cleaning to steel. For surfacing or frosting finished steel or iron, an air pressure of from 10 to 15 pounds is required and for surfacing brass, bronze and aluminum 5 to 10 pounds, and a fine, white, sharp sand, in grade from No. 40 to No. 100, according to the finish to be obtained.

In considering the question of pressures it should be remembered that the pressures named are those that should be obtained at the sand blast, which can be confirmed by attaching a pressure gage to the sand tank, and that if the air has to be led to any distance from the air compressor and receiver, the delivery pipe should be materially increased to allow for friction, otherwise the pressure will fall off and the action of the sand blast will not be up to requirements. With but little foresight and at a very little additional expense, air delivery pipes of ample diameter can be installed up to the sand blast, giving the benefit of the full pressure as well as that of a considerable body of air behind the sand jets.

MOISTURE IN THE AIR.

The article above quoted then speaks of the trouble which may be caused by moisture in the air. "If the air pipe is long," it says, "condensation may take place within it, which if allowed to enter the sand tank would moisten the sand, and care should be taken to remove this either by trapping or by arranging in the piping a U bend, from the bottom of which any condensed water may be drawn off, and by suitably jacketing the main line."

It is the function of the air receiver to dry the air. If the air in the receiver is at its highest pressure and at its lowest temperature the moisture will be deposited there and no moisture will make its presence known. With the receiver located near the compressor, as is customary, the air is not cool enough, but with a long pipe to traverse, not jacketed, and a receiver near the work the air should always be dry enough.

The Mining World finds that 75 mines and metallurgical works in the United States during 11 months of 1908 paid to stockholders in dividends $44,485,705. The copper companies paid $18,276,092. Forty-six gold, silver and lead mines paid $10,926,936. Six zinc companies paid $2,124,000. Six metallurgical plants paid $12,317,434.

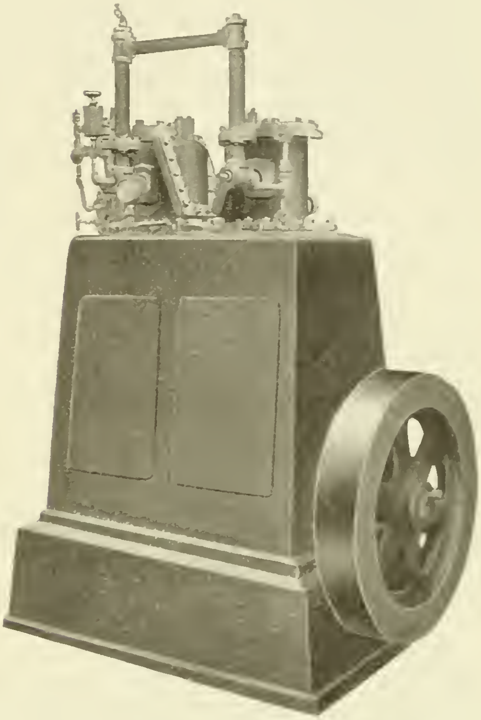
A MONUMENTAL BAROMETER

In celebration of the tercentenary of the birth of Torricelli, the inventor of the barometer, a huge barometer has been constructed in the city of Faenza, Italy. As the liquid used in this barometer is olive oil, the normal height of the column is about 37 feet. It was intended at first to use water, in which case the column would have stood normally at about 32 feet, but this was abandoned on account of the complications which would have resulted from evaporation. Glycerine also was suggested, but the normal height of the column would then have been only 27 feet, which was less than was desired. Olive oil, which was finally determined on, proves to be entirely satisfactory. The tube, which is of iron, except at the top where it is to be observed, is supported by a monumental pillar of stone. The readings are of course affected by temperature, but corrections have been tabulated.

THE WOOD DENSE AIR REFRIGERATING MACHINE

The machine shown in the half tone comprises nothing essentially new in principle, being simply a commercial and convenient adaptation of the dense air, closed cycle refrigerating system so generally employed on Government ships, private yachts and elsewhere. The present apparatus is of a type specially suitable for small units which may be quickly and cheaply installed anywhere, being quite simple and requiring no special skill to operate. The machine may be driven by belt, by electric motor or otherwise as most convenient, and except for this power requirement and the circulating water is entirely independent of everything outside itself.

The responsible elements of the machine are a compressor and an expander cylinder with the necessary operating valves. The same air is used continuously in a closed cycle, the pressure of the return air being maintained considerably above atmosphere. An auxiliary pump makes up for what leakage may occur. The machine requires the connecting of the outgoing and return pipes to the refrigerating rooms. The air compressed is the return air from the refrigerating room. After recompression in the machine cylinder it is passed down to the cooler, which is located in the base of the machine and after being cooled to within a few degrees of the circulating water it is conveyed up again, still under maximum pressure, to the expander cylinder, where it does work in helping to drive the machine and is afterwards discharged into the supply pipe at a reduced pressure and a much lower temperature. The cold air may circulate through a small ice making tank if necessary before going into the circulating coils. The machine as shown is the invention of Mr. Andrew Wood of Bridgeport, Conn., and is put on the market by the Springfield Manufacturing Company, also of Bridgeport.



WOOD DENSE AIR REFRIGERATING MACHINE.

The explosion of black powder produces 33 volumes of nitrogen; 51 of carbon dioxide; 10.5 of carbon monoxide; 3 of water, and 2.5 of hydrogen sulphide. In a mine where there is an excessive use of powder these poisonous and irrespirable gases soon vitiate the air and render it unfit for breathing.

OPERATING CONDITIONS OF STEAM DRIVEN AIR COMPRESSORS

The following we condense from an article by C. A. Dawley in a recent issue of *Power and the Engineer.*

Compressors for ordinary air pressures of 80 to 100 pounds are built with all combinations of simple or compound (two-stage) air cylinders and simple or compound steam cylinders. The straight line machine has been partially replaced by the duplex type, generally having compound air cylinders and often with compound steam cylinders also.

TWO STAGE AIR CYLINDERS.

In compressing air to 100 pounds gage pressure there is a theoretical saving in compound or two stage compression, as compared with single stage compression, of about 15 per cent. This is based on the indicated horsepower required in the air cylinders to compress and discharge a given volume of free air per minute. This theoretical saving is never all obtained, because in the compound cylinders the air has to pass through two sets of inlet and discharge valves instead of the one set of the single cylinder, and it also passes through an intercooler formed of pipes which circulate water to cool the air between stages. In overcoming the friction due to the valves and intercooler and the extra piping, part of the 15 per cent. saving is lost, but there are other advantages of compound compression which make it at least 15 per cent. more desirable than simple compression, provided it does not make the machine too complicated.

Straight-line machines are often built which have compound air cylinders in tandem, with a simple steam cylinder, and they have sometimes been built with compound steam cylinders also. In the duplex compressors there are two steam cylinders and two air cylinders; the cranks are set at 90 degrees, so that one side helps the other over the centers, and it is evident that with this arrangement both the steam and the air ends may be compounded with no more cylinders and with very little increased complication.

STEAM-VALVE GEARS.

The steam valves used on air compressors are of the plain slide type, the Meyer riding cutoff, and the Corliss. Small straight-line and duplex machines generally have plain slide valves, as this is the simplest and cheapest construction. These valves are always set for a late cutoff for two reasons, first to prevent the machine from stopping in going over the centers at slow speeds, and second to avoid an early opening and closing of the exhaust port.

It is a property of the plain slide valve that an early cutoff can be obtained only by permitting an early release of the exhaust steam and an early closing of the exhaust port, which in turn results in high compression in the steam cylinder. In a mill or generator engine, compression is often desirable to cushion the piston and other moving parts and bring them to a stop gradually at the end of the stroke. This makes the engine run smoothly and quietly and is believed by some authorities to decrease the steam consumption. In a compressor, on the other hand, the air cylinders furnish more than sufficient cushioning, and if in addition the steam cylinders had a high compression, the machine would have to overcome the double pressure, which would increase the load on bearings, rods and frames, besides requiring a heavy flywheel to overcome the resistance.

In Fig. 1 this point is illustrated, as applied to a straight-line machine; *A* is the air card at one end of the cylinder, *B* is the steam card at the opposite end of the steam cylinder, which is at that time driving the air out in the direction of the arrow. Card *B* illustrates usual conditions with cutoff at ¾ or ⅞ of the stroke and with corresponding low initial steam pressure. The card shows late release and practically no compression and very little lead; it would be considered an ordinary good card from a plain slide-valve compressor. The card *C* might be obtained with a plain slide valve designed for early cutoff. If we imagine this card as being at the opposite end of the cylinder from *B* and assume that the pistons have nearly reached the end of their stroke at *D*, it will be seen that the pressure exerted by *B* at position *D* is too little to overcome the air-discharge pressure at *D* on card *A* and the steam-compression pressure on card *C* at *D*. The flywheel would then have to carry the machine over against the heavy compression.

Owing to the late cutoff and resulting late expansion, compressors with plain slide valves make little pretension to economy. They are controlled usually by a throttling governor of the fly-ball type, which throttles the steam down to a pressure which will maintain the speed constant as long as the air pressure does not exceed the desired limits. There is an air-plunger attachment to the governor, which still further throttles the steam and causes the compressor to slow down when there is not enough air being used to keep the pressure below the point at which the governor is set.

MEYER VALVE GEAR.

For the purpose of overcoming the defects of the plain slide valve in compressor service the Meyer adjustable cutoff is widely employed. This is the same as the plain valve with its late cutoff, but with the addition of two adjustable plates which seat upon ports at each end of the main valve and are adjusted as to lap by right and left screws on a rotatable valve rod. In starting the machine the rod is turned to give the latest cutoff, and when full speed is attained the cutoff is run back to ¼ or ⅜ stroke, which gives the best economy.

The proportion of the steam cylinders to the air cylinders is usually intended to be such that the necessary horsepower may be developed at ¼ cutoff. In a simple machine, either straight-line or duplex, this involves making the diameter of the steam cylinder the same as that of the air cylinder under usual conditions of steam and air pressure. When run at ¾ cutoff, cylinders of this size are, of course, much larger than needed to develop the required power, and consequently the steam has to be throttled down to a low pressure by the governor.

In running at a late cutoff, the steam used per horsepower is increased on account of the incomplete expansion and also by the reduced steam pressure. The action of this on the cards is shown in Fig. 2, illustrating how the steam pressure in the cylinder varies with the cutoff when the air pressure and speed remain the same. Card *A* is for ¼ cutoff, with maximum steam pressure admitted to the cylinder; *B* is for the ⅜, *C* for ½ and *D* for ¾ cutoff. It is a frequent occurrence to have a steam pressure of 150 pounds in a plant where other engines are running, and at the same time have the compressors getting only 50 to 60 pounds in the cylinder. The increase in steam used per hour per horsepower is shown in curve *A* of Fig. 3, which gives the relative steam consumption of a compressor with simple steam cylinders, when producing the same air pressures and at the same speed, but with the cutoff at different points from ¼ to ¾ of the stroke.

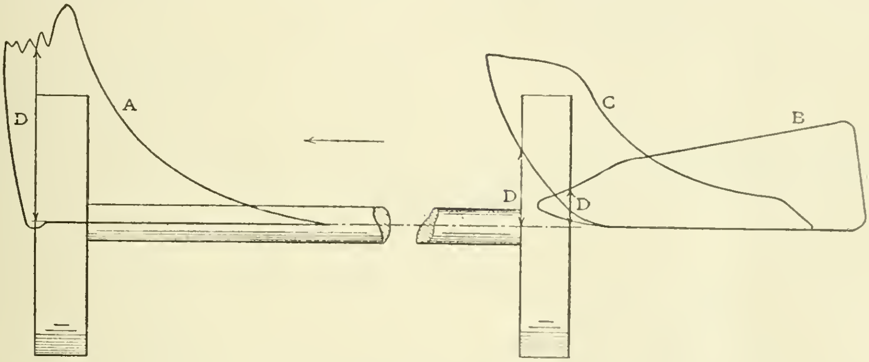


FIG. I.—EFFECTS OF HIGH COMPRESSION.

Here is a detail of compressor management where a careful engineer can save his employer a large percentage of the coal bill, by giving attention to keeping the compressor at its most economical point of operation. The cost of fuel for a machine often equals the total price of a new machine in the course of a year's operation, 10 hours a day, and a saving of 20 to 25 per cent. of this, which is easily obtained by watching the cutoff, is well worth careful attention.

It is not, however, always the fault of the man in charge that he does not run the machine under the best conditions. If the air demand is irregular, so that the speed varies widely, as is often the case, it is found, especially with straight-line machines, that they will stall at slow speeds and not start again unless run at late cutoff. This requires running out the valve wheel and barring the compressor over to restart, which is no easy trick, and it is only human nature that a man should try to avoid this annoyance by leaving the cutoff at the latest point. The duplex machine will seldom stop at slow speeds, unless the cutoff is earlier than ⅝ or ½ stroke. Another excuse for running at late cutoff is that it produces less strain on the machine, and, if the valves are unbalanced, it makes a decided reduction in the friction and the wear and tear on the valve gear. Whatever may be the merits of the possibility of running at an economical cutoff, the fact remains that probably not over 5 per cent. of the machines in service are so run and never will be until some one brings out a successful and practical machine which does this automatically.

SPEED CONTROL.

The air compressor has one property which is not usual in steam-driven machinery, namely, that the resistance is nearly constant for the stroke though the machine may be working at a small fraction of its total capacity. This simply means that it takes nearly the same number of foot-pounds to compress a cylinder full of free air, whether the machine runs slow or fast. Actually, the work is a little less at slow speeds, as the air friction and valve losses are less and the intercooling better, but in a machine of good design the difference between slow and full speeds amounts to only a few per cent.

The steam cylinders of the compressor will increase slightly in work per stroke as the speed decreases, on account of less resistance to the steam getting through the ports. As the air requires less and the steam cylinder would furnish more work at slow speeds, the result is that the steam is throttled more by the governor, and a lower steam pressure in the cylinder will perform the work, but this lower steam pressure does not decrease the amount of steam required as fast as the condensation of the steam increases it. Cylinder condensation, which consumes 20 to 30 per cent. of the steam used in simple cylinders at full load, may increase to double this amount at low speeds.

In Fig. 4 the curve *A* shows how the water rate increases at slow speeds in a simple compressor cylinder, when the position of the cutoff valve and the air discharge pressure remain the same. The vertical distances on the curve represent percentages based on the best results obtained at full speed.

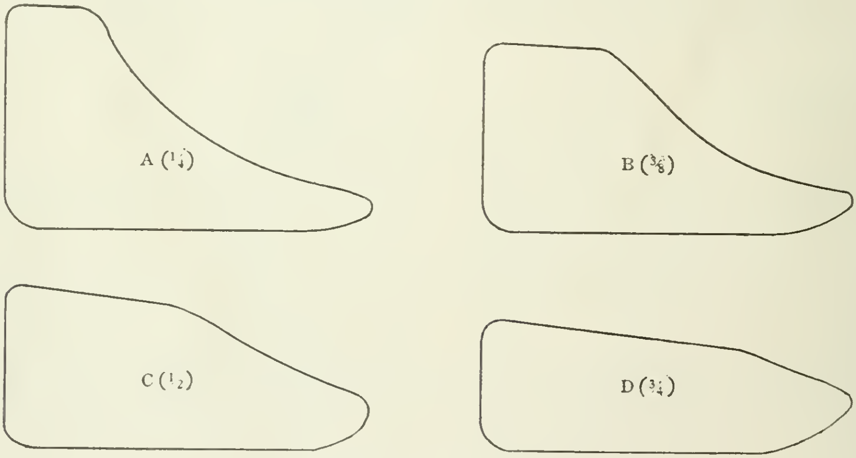


FIG. II.—DIFFERNT POINTS OF CUT-OFF.

Where there is only one compressor, there is no way to avoid slow speeds at times, but in a plant having a number of machines it is important to keep only enough running to furnish the air required, when working near full speed. Some engineers prefer to use more machines and run slower, saying that they have less trouble with bearings, etc., and that machines last longer if run slow. This is undoubtedly true, but if a machine is well designed and built, its life will be a certain number of million revolutions, and the sooner these are run off, the sooner the machine will return its value to the owner. Certainly a saving of 10 to 20 per cent. on the steam used per unit of air furnished, is worthy of some effort to keep the plant operating at its highest efficiency. The uniform load above mentioned, in combination with a proper speed, is capable of producing steam economics not exceeded by any class of steam engine.

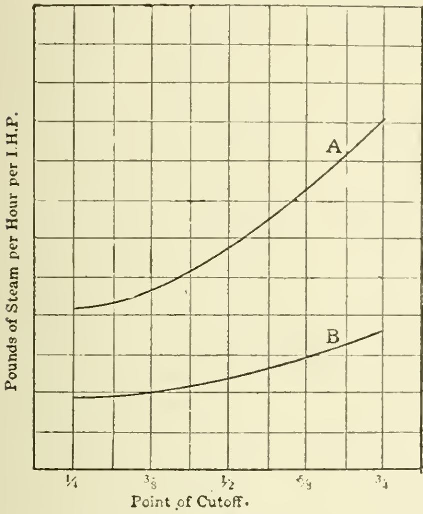


FIG. III.—STEAM CONSUMPTION.

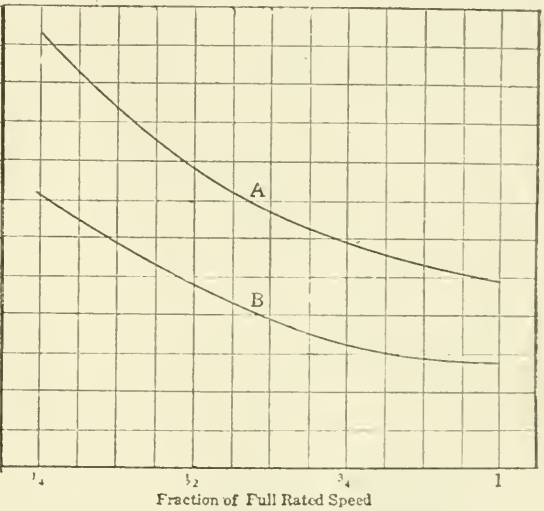


FIG. IV.—WATER RATE.

COMPOUNDING.

This uniform load is also a most favorable condition for compounding the steam cylinders. Many people think of compounding only in connection with condensing and complication, and it is undoubtedly true that in steam engines having an irregular load, the compound non-condensing engine has not much advantage over the simple. But in the air compressor the conditions of load are ideal for compounding, and, moreover, the losses attending late cutoff and slow speed are relatively much less in the compound. In curve *B* of Fig. 3, corresponding to curve *A* for the simple cylinder, it will be noticed that the steam required does not increase as fast at late cutoff as in curve *A*, which is shown by the distance between the two curves being greater at the ¾ mark than at ¼ or ⅜. Also in curve *B* of Fig. 4 it is seen that the speed variation does not affect the compound as much as the simple.

The proportioning of the cylinders of a compound is a matter of much complexity, involving the size of air cylinders, air pressure, steam pressure, types of air and steam valves, speed, method of governing, cutoff in steam cylinders and whether to be run condensing or non-condensing. Most of these can be known beforehand, and in a Corliss or automatic cutoff engine it is possible to get the best economy and also divide the work equally between the cylinders. In a Meyer valvegear machine it is, of course, impossible to get the best distribution unless the cylinders are designed for some definite point of cutoff and used as designed. With the high-pressure cutoff valve set at any point, more work can be thrown onto the high-pressure side by making the low-pressure cutoff later, or if the high cylinder is doing too much work, it can be changed by making the low-pressure cutoff earlier and so increasing the receiver pressure which, in turn, puts more back pressure on the high cylinder and at the same time admits a higher pressure to the low. The compressor should be indicated and adjusted occasionally, noting the best points of cutoff and the corresponding steam and receiver pressures, so that the same conditions can be readily obtained when desired. If the machine is run at late cutoff or if a machine intended for condensing is run noncondensing, there is a chance of very uneven distribution of work and strains in the machine.

THE ANCIENT AND THE MODERN CONTRACTOR*

The contractor did not hold in the earlier reaches of human history the dominant position that is his today on the world's stage. He may have been pre-figured in a crude way in the task-master directing and controlling the human forces, the muscle-power, that gave the world the great wall of China, the hanging gardens of Babylon, the pyramids of Egypt, the Roman highways and aqueducts and the Aztec architecture of the American continent, the brain secrets of which have in some cases been hailed in our day as original discoveries. But that almost pre-historic task-master is, perhaps, best represented in modern times in the superintendent or boss of a piece of municipal improvement work done under municipal auspices and by day labor, with its consequent waste of time and waste of money, which had its similitude in the waste of muscle and energy in the days when the world was young and human life was cheap. The real contractor could not come into his own until steam and electricity had been recognized in all their potency, until the locomotive, the printing press and the telegraph had pointed to the saving of time and strength and to the utilization of natural forces for the conservation of society as its mental vision broadened.

Today the ideal contractor stands for the accomplishment of a task, no matter how difficult, in the quickest time and with the most substantial results justified by the money at his disposal. Whether he devotes himself to a specialty or to general contracting; whether he merely builds bridges or undertakes to establish the grades, lay the rails, span streams and tunnel mountains in creating a railroad, whether he raises one single structure or undertakes to build from the ground up a city, with sewerage, drainage and water systems, to shelter 10,000 persons; whether he agrees to furnish supplies for an army or a navy, to give lighting and heating facilities to a community, to construct an immense dry-dock and to transport it half way round the globe, to remove the debris of a city devastated by fire, flood or earthquake, or to manufacture the thousands of tons of paper called for by the manifold activities of a national government, he must have faith and imagination above all else. He must be able to grasp an infinitude of details and be possessed of a wide range of experience and definite knowledge. Quickness to adapt himself to conditions and to seize the occasion must be his. Faltering for him is failure. Hide-bound, he is limited as to opportunities. Narrow-minded and ignorant, he is a case of false pretense and his days are soon numbered.

Glance over the continents and think of what he is doing. Perhaps I may be permitted to cite a group of allied contracting concerns as typical of contracting generally. Their combined work in North and South America, in Asia, in Europe and in Australia represents an investment of more than $50,000,000 and includes power plants, railways, water-supply systems, harbor works, coal docks, tramways, hotels, office buildings, apartment houses, municipal buildings, warehouses, race-courses, carbarns and electric transmission lines. Their operations are under way at twenty eight places in the United States, thirty places in Great Britain, and in Canada, in the Philippines, in India. China, France, Holland, New Zealand, Brazil, Porto Rico, Mexico, Uruguay and Argentina. In handling material had on the ground or from near-by points, or carried thousands of miles, they employ Mexican peons, British navvies, Hindoos, Indians, bushmen, Filipinos, Chinese, negroes and any of the European stock which has come to be of so much importance in the rough work of American progress.

All that implies a combination of hundreds of energies of various kinds, broad-mindedness, steadfastness, nerve and persistence in the contractors, and more or less involuntary widening of mental activities for thousands of the members of black and brown and yellow races, together with an easing of conditions of life for everybody with a speed and a thoroughness possible only through the control by the contractor of vast forces and immense resources brought into co-operation to a definite end.

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*From a paper by Richard H. Edmonds, C. E., at the Asheville meeting of the American Public Works Association.

THE OUTLOOK FOR THE AIRSHIP

The following occurs in the anniversary address of Lord Rayleigh before the Royal Society on Nov. 30th:

"I cannot abstain from including in the achievements of the year the remarkable successes in mechanical flight attained by the brothers Wright, although the interest is rather social and practical than purely scientific. For many years, in fact, ever since I became acquainted with the work of Penaud and Wenham, I have leaned to the opinion that flight was possible as a feat.

"This question is now settled and the tendency may perhaps be to jump too quickly to the conclusion that what can be done as a feat will soon be possible for the purposes of daily life. But the fact is there is a very large gap to be bridged over, and the argument urged by Prof. Newcomb and based on the principle of dynamical similarity, that difficulties must increase with the scale of the machines, goes far to preclude the idea that the regular ocean service will be conducted by flying machines rather than by ships.

"However, as the history of science and invention abundantly proves, it is rash to set limits, and for special purposes, such as exploration, we may expect to see flying machines in use before many years have passed."

SOME AIRSHIP SPECULATIONS

I happened just now to run across an old encyclopedia that I used to study when I was a very small boy. As I looked into it I turned to an article entitled "Flying, Artificial," which seemed to link the present with the past, and to connect some of the experiments of recent date with my own flights from the shed roof with the aid of an umbrella, neither being much more certain of success than the other. As I read the article I became more impressed at the lack of progress that 30 years or more have seen, and still more impressed with the idea that progress in the future will be a matter of machine work more than anything else.

There appear to have been two semi-successful attempts at flying by manpower, one about the latter part of the 17th century consisting of two poles fastened over the shoulders by straps (see Fig. 1), to which were fixed a pair of wings at each end. These wings were flexible so that they yielded on the up-stroke and spread open on the down-stroke. The operator pulled down on them in front with his hands and then pulled down behind by means of straps which were attached to his ankles. We need not be surprised to read, "Besnier was not enabled to rise direct from the ground, but by starting from an elevation he flew across rivers of considerable width, and a pair of wings which he sold to another was used with similar success." The most surprising thing was that the second pair were usable. The proportions which the accompanying cut show are manifestly impossible, as I know from my experience with umbrellas.

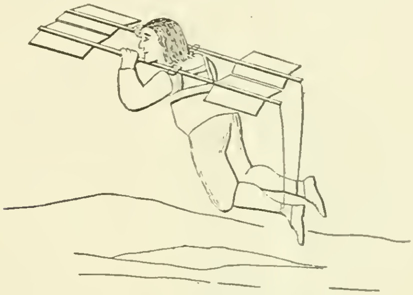


FIG. 1

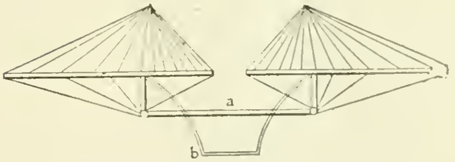


FIG. 2

One hundred and twenty-five years later one Joseph Degen, a prisoner at Vienna, made a pair of wings similar to Fig. 2. He sat on the cross-bar *a* holding himself down on it with both hands, and pushed down on the stirrup *b* with both feet. "With this machine he rose to a height of 50 feet, measured by a cord held by the jailer to prevent his escape. This was done in two minutes' time, but the effort quite exhausted the strength of the adventurous mechanic."

Since then there probably has never been a time when no one was experimenting, or at least planning, some kind of an air ship. The most noticeable difference is in the size of the claims.

AN ENGLISH ATTEMPT.

Probably the most pretentious proposal was in England in 1842 when the House of Commons was asked to incorporate a company to float an aeroplane to carry letters, goods and passengers. The apparatus was to weigh 3,000 pounds including coal and the plane to have an area of 4,500 square feet. No mention was made of the number of passengers, but assuming the average man to weigh 150 pounds he would have a plane 15 feet square which is not very far from the size of the parachutes used in sensational leaps. Evidently safety depended on getting up high enough so that the aeroplane would have time to develop resistance to falling. This was the first time that it was proposed to run a machine down an inclined plane, until its planes caught it up and enabled it to start through the air. Not a desirable feature if one happened to alight on a deserted farm for extra fuel.

The few attempts at power propulsion which went beyond the paper stage showed that lightness of motive power was the one consideration above all others. In 1868 a steam engine was built with a cylinder 2 inches in diameter, 3-inch stroke running at 600 revolutions per minute on a boiler pressure of 80 pounds per square inch; which, if figured on 40 pounds mean effective pressure, would give a trifle over half a horsepower. The total weight of engine and boiler was 13 pounds. Today an ordinary motor-cycle engine will not weigh over 26 pounds per horsepower with all accessories weighed in.

The first attempts in this country were in the line of dirigibles. Rufus Porter, of New Britain, Conn., built a machine on a small scale in 1833. About 1850 he exhibited a model 22 feet in length, and 4 feet in diameter on almost precisely the lines followed by the air ships used in public exhibitions. It was driven by steam, and indoors only. A full sized vessel 160 feet long proved to be a failure because of the impossibility of keeping the gas from escaping, which sounds as if it might have been clipped from a very recent paper. A certificate of stock in Porter's company has just come to light in the Worcester, Mass., registry of deeds, the text of which follows:

AN OLD STOCK CERTIFICATE OF AN AIR-SHIP COMPANY.

Whereas I, Rufus Porter of the city and county of Washington and District of Columbia have invented an apparatus denominated an aeroport for the purpose of aerial navigation, and have commenced arrangements for constructing two of said aeroports, the first to be 150 feet in length and capable of carrying five persons and the other to be 700 feet long and capable of carrying 150 persons safely at the rate of 90 miles per hour, and whereas George Eaton, of Worcester, county of Worcester and State of Massachusetts, has expressed a desire of obtaining an interest in said aeroports: Now this indenture witnesseth that for and in consideration of the sum of $5 to me in hand paid, the receipt of which is hereby acknowledged, I have assigned and transferred, and do hereby assign and transfer to the said Eaton, one undivided three-hundredth part of said first aeroport that shall be constructed, and also one undivided three-thousandth part of all benefits and emoluments that may arise or accrue from the said large aeroport for twenty years from the time the said aeroport shall have been put in operation. And I herewith covenant with the said assignee that I will proceed forthwith and contract said two aeroports according to my proposition and prospectus published in the *National Intelligencer* of the 19th of March, 1852, and to keep the said large aeroport in repair for 20 years." All of which shows about the same degree of confidence that prevails today. The dirigible balloons of recent years are broadly different in plan or hopes from those of half a century ago. The more recent experiments are yet hardly passing into history. The remarkable thing is that in all this time so little has been learned. It has seemed to be a repetition of failure with little variation in the means used to reach it.—*American Machinist.*

PRECAUTIONS IN USING ELECTRICITY IN MINES

The United States Geological Survey, in a report on the prevention of mine explosions, recommends the following precautions:

"For distribution underground the voltage should not exceed 650 direct current or 500 alternating current, these voltages being intended for transmission to machinery operating at 500 volts direct current and 440 volts alternating current, respectively. Even lower voltages are preferable. The trolley wires should be installed in such manner as to render shocks least likely—that is, placed either high enough to be beyond easy reach or at one side of the track and properly protected.

"Where current at a potential of more than

650 volts is employed for transmission underground, it should be transmitted by means of a completely insulated cable; and where a lead or armored covering is used, such covering should be grounded.

"In all mines having electric installation special precautions should be taken against the setting on fire of coal or timber. Inclosed fuses or cut-outs are recommended, and each branch heading should be so arranged that the current may be cut off when necessary.

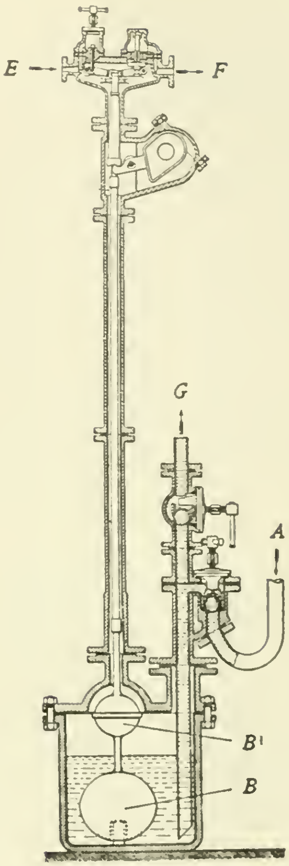
"No live wire should be permitted in that part of any mine in which gas is found to the amount of two per cent.

"In all mines producing gas in dangerous quantities, as indicated by a safety lamp which will detect two per cent. of gas, the working places should be examined by a qualified man using such a lamp immediately before any electric machine is taken or operated there."

For compressed air no precautions are suggested.

THE AUTOMATIC MONTIJUS

The word designating this device comes from the French. It is used in sugar refineries, and especially in chemical works for lifting or transferring liquids, compressed air being employed as the agent and the apparatus being so designed that the corrosive acid or other deleterious liquid shall not come in contact with the operative parts. The cut herewith is reproduced from *Electrochemical and Metallurgical Industry*. In the type here illustrated the liquid has run to the machine by gravity, entering at A through a check valve. Let us assume that the tank is empty and that the full weight of the lower float B keeps the exhaust valve F open, so that the liquid can freely run into the tank. The liquid rapidly covers the lower float B, but the buoyancy thus started is not sufficient to open the air valve E. This is accomplished when the liquid reaches the upper float B¹. The combined buoyancy of both floats shuts the air exhaust valve F and opens the compressed air inlet E, the liquid being now discharged through the check valve and the discharge pipe G. The level of the liquid drops now rapidly below the float B¹, but the weight thus exerted is not yet sufficient to shut the compressed air inlet valve. This is accomplished after the liquid has dropped below float B, the weight of the floats being now sufficient to shut the air inlet valve and to open the air relief valve. The conditions are now again the same as at start and the operation is repeated.



COAL DUST AND MINE EXPLOSIONS

Mr. Wm. N. Page, President of the West Virginia Mining Association, in a recent paper presents some rather unusual considerations upon this serious topic.

After a careful study, he says, of the excellent paper of Mr. Haas, read before the Charleston meeting of the West Virginia Mining Association, Oct. 7, the report of Messrs. Desborough, Miesner and Wattagne, to the Secretary of the Interior, and an article written by James Ashworth of Edgcroft, England, and many other similar reports and experimentations, two facts seem to be fairly well established, to which I wish to direct the attention of mine owners and operators as of vital importance in connection with dust explosions.

(1) Dust, as dust, is not explosive.

(2) It is a physical impossibility to moisten dust to the point of safety, in high velocity currents.

In reference to the first, dust being simply a mechanical division of coal, a chemical alteration must be essential to an explosion, but the division may be so fine as to render the chemical reactions practically instantaneous; and I am satisfied that a mine entry filled with a whirling mass of dust in suspension is a dangerous element, which will augment, or produce, an explosion in contact with the requisite temperature and flame areas. The explosion being due to the gases generated by the rapid flaming of the dust, it follows that the danger lies with this dust in suspension over large areas, and that the dust is harmless when at rest.

In reference to the second point, Mr. Asheworth, quoting freely from Mr. Stokes, H. M. Inspector of Mines for Great Britain, and referring to particular disasters, shows from hygrometric observations, that neither complete saturation of the air currents, nor wet walls, roof and floor, nor all combined, will remedy the danger. Mr. Asheworth says "A practical demonstration of the correctness of these experiments was afforded by the Universal colliery explosion, where the flame of the explosion traversed the whole of the east side districts, although this side of the colliery was naturally wet and the air saturated with moisture; and this proved that the saturation of the roof, floor and sides will not reduce or prevent the extension of an explosion in a mine, as Messrs. Scholz and Stokes appear to have concluded. It has, however, been proved by German experiments that if water is used for the purpose of restricting or preventing explosions, it must be so considerable in quantity that it may be squeezed out of the dust with clenched hand, etc." I think we must all admit that it is a practical impossibility to keep mine dust in such a state.

TOO MUCH AIR THE GREATEST DANGER.

In olden times, when we had to depend on gravity and slow currents for ventilation, no one ever heard of dust as an element in explosions, and even now, I know of no disaster remotely attributable to dust, where high pressure fans were not employed. Until comparatively recently all explosions were attributed to fire damp, and to guard against this danger we have created a new danger in the enormous volume of air traveling at high velocities through restricted channels, which pick up every particle of dust within reach and keep it in suspension. Just as the remedy for fire damp has developed the more serious problem of dust, so will the remedy now universally proposed for dust result in a greater danger from water, because water will not only affect the health of the miner, but it is the indirect cause of every death from roof falls. According to the U. S. Geological reports, 66 per cent. of all underground fatalities is attributable to the fall of roof and coal, and only 34 per cent. to all other causes, and I presume it would be fair to assume that not more than 5 per cent. of deaths can be traced to dust explosions. It would seem therefore, that the remedy of water proposed in the effort to save five lives is now the death portion of 66, and any increase of water in the mine must necessarily add to roof fatalities.

Slate or fire clay probably constitutes over 99 per cent. of the mine roofs in West Virginia, and every practical miner knows that these slates and clays disintegrate rapidly when exposed to atmospheric air and weather on the dumps or spoil banks, and when we force 200,000 or 300,000 cu. ft. of air per minute through the mine at high velocities, we are simply introducing outside conditions underground; consequently the roof constantly disintegrates, crumbles and falls as it would do if the same material was exposed outside; and the more water introduced either by sprinkling or saturation of the air, the more deadly will be the consequences. We had a single-phase danger with fire damp, a two-phase danger with dust, and we will have a three-phase danger with water, more deadly than the other phases combined.

In my humble opinion the proper remedy for dust is not the application of water in any form, as it is not only of doubtful value in relation to the dust, but is unquestionably far more dangerous to life and the mine than all other elements combined.

The only effective remedy is the closing down of the ventilating currents to a velocity at which they will not carry dust in dangerous quantity, and this I believe can be done and still supply the mine with all the air necessary for the dilution of the gases, respiration and combustion. Any more than a sufficiency for these purposes must be a positive evil through both roof and dust. The tendency heretofore has been to regulate by statutes the specified volumes of air per minute for each man, animal, and light, without any limit beyond the statutory specifications, and the mine inspectors have all considered high velocities as the most desirable attainment, the higher the better, with an eye single to fire damp and pure air for the miner. It seems to me, however, that the time is come when the law-makers and mine experts should study consequences, as too much of any good thing must always be harmful.

Instead of forcing 200,000 cu. ft. of air per minute (or more) through restricted air ways and passages by a single fan, under sufficient pressure to permeate every part of a torturous mine, necessitating high velocities in many passages, I would suggest that the current be split as often as possible, and a number of auxiliary fans be substituted for one powerful single unit. Five fans delivering 40,000 ft. will be preferable to one delivering 200,000 ft., not only because of the slower velocities, but from an actual saving of power through loss of friction. Such small units placed within the mine will operate as force and suction at the same time, and since electricity is now almost universally employed underground, there is no mechanical or other difficulty in the way of installation. The cost of the small units combined will be little (if any) greater than a single unit of equal capacity. Where there is more than one intake and outcast, there is no problem involved, and in shaft mines with limited entrance, the difficulties would be neither great nor costly, as the necessary intake and outcast where the velocities might be high, could be easily isolated from all danger. In other words, the currents could be passed through auxiliary fans and slowed down, just as an electric force can be stepped up or down through a rotary converter. With such arrangement a uniform volume of air, under slow velocity, could be more satisfactorily distributed across all working faces, as a small motor driven fan could be moved from place to place, with little loss of time or money.

I make these suggestions simply to direct the attention of our mine managers to the subject, being fully convinced that water is not an effective remedy for the prevention or restriction of explosions attributable to dust; but granting, for the sake of argument, that it is a preventative, and that dust can be settled by a spray or humidity, its application is too expensive, uncertain, and dangerous, for practical purposes. Death from roof falls is like the falling of leaves one by one, making no disturbance; but an explosion, which kills in groups, though only one-thirteenth as deadly, is like a conflagration which fires the imagination of the public.

In our efforts to protect life and property, we must look to the falling leaves as well as to the burning bush, and the men who die one by one under roof falls, are as much entitled to protection as are those who lose their lives in a spectacular disaster.

SUBMARINE SIGNAL BELLS FOR LIGHTSHIPS

Submarine signals are now stated by many authorities to be the only reliable aid in foggy weather. The system is far beyond the experimental stage and is in successful use both on our own coasts and in some foreign countries. The usefulness of the system is restricted by the fact that it is necessary to install receiving apparatus upon the vessels to be warned. Commander R. F. Lopez, U. S. N., Inspector of the Twelfth Lighthouse District, on the Pacific Coast, writes upon this topic to *Railway and Marine News*, Seattle, Wash.:

On the Atlantic coast, and in foreign countries where the apparatus has been installed, masters of vessels have come to rely implicitly on the submarine bell signals, by means of which they navigate their ships with almost as much certainty in fog as in clear weather. It is now a common thing for the captain of one of the great ocean liners to come on the coast of the United States, get his bearings at Nantucket shoals and proceed to New York Harbor, all by the sounds of the bells coming to him through the water, without being able to see any one of the three lightships, or to hear their aerial fog whistles. Oftentimes in making Cape Flattery in foggy weather masters are unable to pick up Umatilla Lightship, and must haul in and get their position by sounding. This is often dangerous, especially with a heavy sea running, but with a submarine bell the lightship could be located and the vessel go on about her business.

THE SIGNALING APPARATUS.

The bell is lowered over the side of the lightship; being suspended on a davit, similar to a small boat davit, a chain is attached to the bell, the upper end of which is run over a sheave, thence to a hand windlass which is attached to the davit at the rail. By means of this hand windlass the bell can be raised or lowered. A twin hose, which has two passages, runs from the deckhouse over the sheave and down to the bell to supply air for the bell and the means for striking a code, and also for the exhaust air from the bell to return. This hose is lashed to the chain after passing over the sheave to keep it from slapping against the chain and wearing out. These lashings are roughly six feet apart. The bell is lowered about 25 feet under water, and is rung automatically by means of a code mechanism which is situated in the engine room. This code mechanism is driven by belt from the air compressor (which is a single acting steam air compressor), or in case the lightship does not have steam, this can be a belt driven compressor, driven either by belting it to some shaft such, for instance, as the shaft of an air compressor for the fog horn, or may have its own oil engine with means for driving our air compressor and can, therefore, be adapted to whatever conditions exist on the lightship.

The bell casing is divided into two parts, the lower part being a reservoir into which one of the passages from the hose leads. The air in here is kept at a constant pressure of about 25 lbs. per square inch. The second hose leads to an auxiliary diaphram and air of about 7 lbs. pressure is admitted to this by means of a code ringer. This code ringer has a wheel with dogs spaced for any given code; for instance: Blunts Reef Lightship rings the code of 83 (8 strokes, 3 seconds, 3 strokes, 5½ seconds). This auxiliary diaphragm opens a valve which allows the air from the main reservoir (the bottom half of the casing) to rush under the main diaphragm, bulging the main diaphragm upward. The main diaphragm has connected to it a pull rod for the bell clapper, and each time air is admitted under it and it rises a blow is struck on the bell. The hammer is returned to its position after a stroke, partially by gravity and partially by the aid of a spring which insures its quicker action. The air, after leaving the air compressor and before it enters the bell, is thoroughly dried by passing through a heater and condensing the water out of it.—[This must be a cooler instead of a heater, Ed. C. A.] After it has passed through the bell it is returned to a tank in the engine room and used over and over again. A small inlet valve which works automatically supplies any fresh air that is needed to make up for the losses. It is necessary to dry the air in order that the moisture which is in it will not condense in the bottom of the bell and tend to fill the reservoir. During cold weather these bells should be taken aboard every week or two and any moisture which has collected in the bottom drained out by taking out a small plug prepared for the purpose in the bottom of the reservoir. Although the bell will run even with this reservoir full of water, its action is a little better if the reservoir is kept empty.

RECEIVING APPARATUS.

The receiving apparatus consists of two tanks, which are bolted against the inside skin of the ship about one-half way down the turn of the bow, and as far under the water line as it is possible to get them. No hole is made through the side of the ship, but the open end of the tank which goes against the skin of the ship has a rubber gasket placed around to make it watertight, and the tank is then filled with a solution of fresh water, to which salt is added, making it about the density of sea water. There are suspended two microphones in each of these tanks. These microphones are exact duplicates, and are used as auxiliaries, in case of an accident happening to one the other set can be thrown in. The forward microphone in each tank constitutes the "A" set and the aft microphone in each tank constitutes the "B" set. These microphones are very carefully paired and balanced before leaving the factory, so that the starboard and port microphone of each set are as nearly as possible absolutely the same. The microphone itself consists of a granular button enclosed in the composition case, having a diaphragm on one side, to which the button itself is attached. This is keyed to take the tone of the bell, which is hung over the side of the lightship. It will also pick up other noises; for instance, the propeller of a passing steamer can be heard, but it responds best to the pitch of the bell, which is used on a lightship. This is 1,215 vibrations a second. The wires from this microphone lead up from a small battery box, from the batteries of which the electric current is supplied, to a box which is called the indicator box. This box has a switch in the middle of its face and the wires are so connected that when this switch is thrown to one side the observer is in communication with the microphone in the port tank, and when the switch is thrown to the other side the observer is in communication with the starboard microphone. There are two small knobs at the bottom. When the one on the left is pulled down a small light is thrown on behind the words, "port" or "starboard," when in use at nighttime. The one on the right throws on the auxiliary set of microphones (the "B" set) in case any accident should happen to one of the "A" set of microphones. Two receivers are placed on this box. They are both connected exactly the same, and either one, or both, may be used in making observations. When there is any great amount of foreign noise, such as talking in the wheelhouse, or the noise of the wind in case of a storm, the use of two receivers gives better results.

The bell on the lightship can be picked up with this receiving apparatus ordinarily at from four to eight miles. It has sometimes been heard as high as sixteen or eighteen miles, but these are exceptional. The advantage of the system is that the exact direction of the bell can be obtained on the receiving apparatus by listening first to one side and then to the other. The bell will sound loudest on the side on which it is, and if the exact direction is to be obtained the vessel is swung slowly towards the side on which the bell sounds loudest until the bell sounds equal, when the switch is thrown to starboard and to port.

FOR AIR HARDENING MACHINE TOOLS

Mr. Ethan Viall has sent to the *American Machinist* the sketches here reproduced which originated with Mr. Charles Burgess of the Cyclops Steel Works. Anyone is at liberty to use the devices.

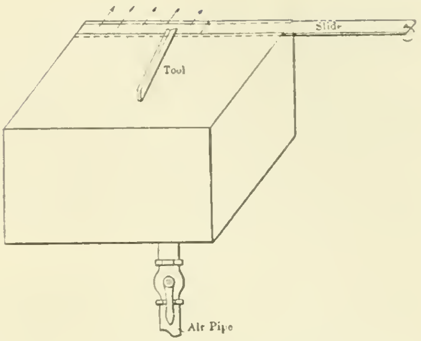


FIG. 1. FAN BLAST BOX FOR AIR COOLING STEEL

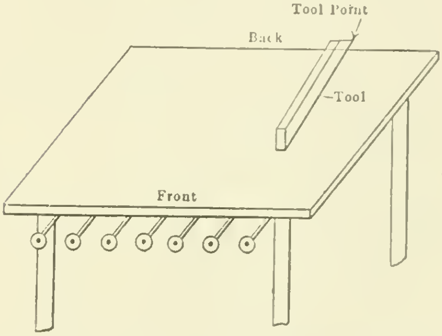


FIG. 2. TABLE FOR USING COMPRESSED AIR

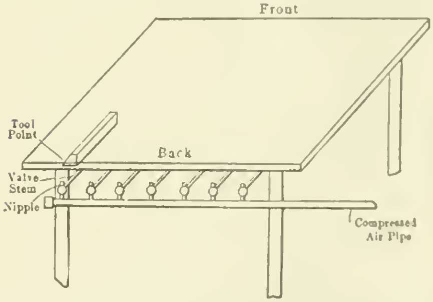


FIG. 3. BACK VIEW OF TABLE

Fig. 1 is a box arranged for cooling tools when air from a fan is used. The box may be made all metal or of wood with a metal top. The slide shown, is for the purpose of shutting off part of the blast when only a few tools are to be cooled and the arrows show the current of air. In a box arranged in this way the current of air strikes just right, that is a little back of the cutting edge of the tool and passes off at its point. This is the best fan blast cooler for this class of tools that I have seen.

Figs. 2 and 3 are two views of a cooling table for use when compressed air is used. On this table as many tools may be cooled as there are jets. The valves have long stems which extend clear under the plate, and they may be turned on or off from the front.

The plate used may be of boiler iron or a slab of cast iron and anyone can easily fit up the necessary pipes, valves and jets. In some cases it would perhaps be better to use small steam cocks or gas jets and open them from the side they are on, instead of using the long valve stems. This, of course, depends a good deal on the way a man is used to handling his tools and the situation of the table.

THE AEROLITH IN AUSTRIAN MINES

Consul Joseph I. Brittain, of Prague, gives us more detailed information of the "Aerolith" breathing apparatus invented by Engineer Otto Suess and previously mentioned in our columns. The Aerolith uses liquid air, and has been made practicable by recent developments which have so cheapened the liquid air and made it easily obtainable.

The Suess machine consists of a reservoir in the shape of a knapsack, which is carried on the miner's back. This reservoir is filled with liquid air, 3 qts. to 4 qts. being sufficient for two hours. The apparatus is connected by two tubes to a respiratory mask fixed in front of the mouth of the miner, so he may readily inhale the liquid air. The reservoir containing the liquid air has an alarm clock attached to it which warns the miner when the two hours have elapsed. It is claimed that the invention has produced very good results, and at some of the mines laboratories for the manufacture of liquid air are being erected in order that the management may always be prepared.

A LIQUID AIR DREAM

We may be very sure that the possible uses of liquid air are as yet very far from being developed or even thought of. Some of the impossibilities in connection with the utilization of liquid air are, however, quite definitely settled, so that there are many things which those who are sufficiently informed will not attempt to do with it. We therefore in no way endorse the following, which comes from an English automobile publication.

In the writer's view, the advantages of liquid air over petrol are many, among them being absence of combustion, heating, sooting, smell, smoke and noise. Further, the car could be gearless and be able to run for long periods with a tithe of the attention ordinary cars require at present. Its chief disadvantages are two:—The difficulty of keeping it either confined or in a free state, though cars are now in existence having tanks in which liquid air can be safely carried. Liquid air is not a fuel, being merely ordinary air reduced to a liquid state under great pressure, which, when allowed to expand again, exerts enormous pressure. Indeed, it is calculated that if a couple of teaspoonfuls of the liquid are placed in a strong metal cylinder one inch in diameter and six inches in length they will, at the normal temperature of 60 degrees Fahrenheit, exert the tremendous pressure of 12,000 pounds, or about five tons per square inch.

In the experimental cars referred to the liquid is merely allowed to drop into the vacuum container, which is really a copper tube radiator exposed to the air. When vaporized it is taken to a small reciprocating steam engine at about 100 pounds pressure per square inch, but higher pressures are needed to give really efficient results. As regards cost, liquid air can, it is understood, be supplied very cheaply, so that it would seem as if a promising future lies before experimenters in this direction.

FOR TUNNELS UNDER THE DELAWARE

It is now tolerably certain that Philadelphia will soon follow the example of New York by driving tunnels under the Delaware. Gov. Stuart recently signed a charter for the Delaware Tunnel Railroad Company, and almost simultaneously Gov. Fort of New Jersey, signed a charter for the Camden Tunnel Railroad Company, the object of both corporations being to begin immediate work upon the construction of tunnels under the Delaware River between Philadelphia and Camden. According to the plans as they now stand two tubes will be constructed, one fom Second and Chestnut streets and the other from Second and Arch streets, both ending at Third street, Camden. Further, the promoters plan to build an elevated road to the eastern boundary of Camden and to transport passengers from Philadelphia to that limit for five cents. The necessary $15,000,000, it is said, has been assured by prominent financial interests.

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DEVELOPMENT OF AN ART

The notable article by Dr. Rossiter W. Raymond on the Gayley Air Blast, which we have the pleasure of presenting to our readers in the present issue, is eminently characteristic of its author. It is the strongest and most convincing presentation of the claims of the Gayley invention as such which has yet been made, and it is at the same time highly suggestive upon the general topic of invention and industrial progress and provocative of thought beyond the actual writing.

The value of the improved metallurgical process referred to has been given out to the engineering world as consisting in the reduction of the ultimate cost of the metal produced, but it is here made to appear that far higher claims than this may be made for it. The ancient producer of and worker in metals could get his iron ore and his wood or charcoal together, and with great waste of material and of labor he could bring out the metal in small masses and of uncertain and very different qualities, and from numerous samples he could and did select some which proved to be excellent steel, while other samples graded down through various degrees of worth or of worthlessness.

This uncertainty of result was the characteristic of all the ancient arts, even of the so-called "lost" arts. They were not arts at all, for a true art approximates to not only the highest economy of means and materials but also to certainty of result, and the development and the perfecting of modern industrial arts have been especially in the direction of certainty and of constant reliability of product. Metallurgy becomes more completely an art because of the Gayley Air Blast, for the product of every blast furnace to which it is applied becomes at once more reliable and more closely satisfying the predicated requirements as to quality of product. The actual saving by the Gayley Air Blast is at both ends of the process. Not only is fuel saved and the total output increased, but also the quantity of the product which must be rejected upon inspection is considerably reduced.

This is progress in the right direction, and progress of this character is to be noted in all the arts. Of those with which compressed air is most in touch may be cited the arts of quarrying and tunneling. The old way of getting out stone was to drill holes in the rock almo haphazard, then to use charges of explosive as big as possible and to select from the chunks thrown out those which could by any possibility be used for any purpose, the majority of the mass going to the dump. Today the stone is cut in the bed precisely to predetermined lines and the stone brought out can generally be guaranteed in every particular before operations are commenced. Tunnel work also is conducted with precision resembling that of the modern quarry, and this is true mechanic art.

TWO SEVERE MINE EXPLOSIONS

The record of the year just closed contains an alarming number of disastrous mine explosions, and two of the most severe of these occurred near the end of the year, one near the beginning and the other near the end of the month of November, the former in Germany and the latter in the United States.

In the first of these 380 miners were cut off at the Radbod mine, three miles from Hamm, Westphalia, by explosion and fire, and 339 perished. Only six managed to escape when the blast came and thirty-five were rescued severely injured. The disaster, which was the greatest of its kind Germany has had in many years, occurred at 4 o'clock in the morning. A tremendous explosion, shaking the whole countryside, was heard, and dense smoke began to pour from the shafts. Rescuers encountered obstacles which for a long time barred their way. The force of the blast damaged one of the shafts, which had to be repaired, and the flames and smoke made it impossible for any human being to enter and live. A special body of men who had gained fame by heroic work in the Courieres, France, disaster, in March, 1906, were among the rescuers, but even these were forced to wait for hours until the firemen had sufficiently subdued the flames to permit any attempt at rescue. The fire began to gain on the firemen, all the relief parties were called out and the workings were finally flooded to extinguish the fire.

On Saturday morning, Nov. 28, 1908, an explosion occurred at the Rachel shaft of the new mines of the Pittsburg-Buffalo Company, at Marianna, Pa., by which 138 men lost their lives. This mine, not yet quite completed, only main entries having been cut and progress made in tunneling to connect with another shaft half a mile away, was one of a group being opened by the Pittsburg-Buffalo Company, with the advice of the most expert mining engineers in the world. Every contingency had been taken into consideration and all means were provided to insure the safety of the men who were from the beginning and who would ultimately be employed in the mine. This mine was thoroughly explored by the foreign experts who recently visited this country under the auspices of the United States Geological Survey, and was by each of them pronounced one of the most admirable in its engineering and lavish in its equipment they had ever seen.

The shaft at or near which the explosion occurred is 488 feet deep. State Mine Inspector Louthitt had just emerged from the shaft having found everything in perfect order. The cage had just been started on the downward trip again when the explosion came. The cage was driven out of the shaft and to the top of the head house, falling back on its side, the three men who were in it being killed. A mine foreman, who was in the cage, was picked up dead several hundred feet away. The explosion was at 4 o'clock Saturday morning and the first rescue party got down at 2 o'clock in the afternoon, bringing out only one man alive.

No official statement has at this writing been made as to the cause of the disaster. At least three theories have been advanced.

1. Explosion of dust which might have been ignited by an electric spark from a mining machine or by a shot fired.

2. Marsh gas or fire damp ignited by either of the above causes or by an open lamp.

3. Presence of natural gas which at times had been found in the mine and which came from all over the adjacent territory.

James E. Roderick, chief of the Department of Mines of Pennsylvania, said:

From the reports I have received I believe the accident was due to a blown-out shot; that is, an overcharged hole in which the powder had flashed out, setting fire to the coal dust in the mine. No devices have been invented which will prevent such an accident as this, if, as I believe, it was due to a blown-out shot.

An old oil and gas well driller of the region says that he has often when drilling wells found pockets of natural gas in the coal measures of sufficient volume to set fire to his rigs, and has himself been seriously burned therefrom. It is his idea that such a pocket was tapped by the workers in the mine, and that it came in such volume as to fill the entries, so that it would have been impossible for the men to have escaped from it before the explosion took place.

THE UPS AND DOWNS OF THE YANKEE

The U. S. cruiser Yankee, stranded on Spindle Rock, Buzzards Bay, Mass., late in September, was floated and pulled from the rocks on Dec. 4 and sank twelve hours later in Buzzard's Bay near Penikese Island. She is in comparatively shallow water, resting on even keel and it is expected that there will be little difficulty in raising her, so that we may hope in a succeeding issue, to tell the story all at once. After the failure of attempts made by the Government engineers to raise her a contract was awarded to John G. Arbuckle of Brooklyn to do the job by the aid of compressed air. The attempt to raise her succeeded, but while she was being towed to New Bedford to be dry-docked, the services of the air compressors being still required to keep her afloat, the hawsers parted and she was struck in the side by one of the tugs. The compartment penetrated was where the compressors were working, and when they stopped down she went again.

A COAL MINE THEATRE

For educational and experimental purposes, and entirely without advertising intent, the United States Geological Survey is about to establish at Pittsburgh a novel exhibition. It will be in the top story of a large building, occupying the entire floor, which will be divided by a glass partition, on one side will be accommodations for spectators and on the other side an interior of a coal mine will be reproduced as realistically as possible.

Coal operators in various parts of the country will be invited to send intelligent men, who are practical miners, to watch the performances at the theatre, and to take part in them when they choose to do so. The room on the stage side of the air-proof glass partition will be filled, for one experiment, with firedamp. Then men will go into it with patent helmets on their heads and oxygen apparatus strapped on their backs, and will show how long it is possible, with such aids, to remain safely in the poisoned atmosphere.

There will be a sort of walking track, of so many laps to the mile, around which the miner, wearing helmet and oxygen machine, will perambulate—the idea being to find out how much bodily effort he is capable of under such conditions. In order to vary the tests as much as possible, men will be required to do a variety of difficult stunts, such as walking up a high ladder, crawling through a long, dark passage, and coming down another ladder, just as they might be obliged to do in a real mine—repeating the performance, perhaps, with a dummy man carried in the arms.

It is altogether likely that some of the men subjected to these tests will succumb—in which case an emergency door in the glass partition will be instantly opened, and the victim of gas poisoning will be pulled out and revived. The expectation is that in this manner an accurate measurement will be obtained of the amount of work a man engaged in an effort of rescue in a mine can be expected to do, and of the length of time during which it would be safe for him to remain within the precincts invaded by poisonous gases.

The miners, who, as observers of or participants in the performances in question, derive practical information therefrom, are expected to become in their turn instructors.

CALCIUM CHLORIDE AS A PREVENTIVE OF FREEZING IN AUTOMATIC SPRINKLER SYSTEMS.*

In the protection of factories against fire by the automatic sprinkler system, a herring-bone system of small water pipes is spread over the ceiling with fusible sprinkler heads distributed so that each head protects an area of about 100 square feet of ceiling above and floor below. These heads are usually designed to melt at a temperature of about 150 degrees F. so that any fire starting beneath them and causing them to attain that temperature is automatically quenched by a jet of water released from the pipes through the melted sprinkler head.

In cold buildings these water pipes are apt to freeze; to prevent which, it has been customary to fill the pipes with compressed air, an air valve being placed in the main water-supply pipe just below the freezing line. The air valve may be underground or in a room sufficiently warm at all times to prevent the freezing of the water pipe just below the valve. This air valve, which is really a check valve

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*Rutger B. Green in *Cornell Civil Engineer.*

against the air and separates the air-filled part of the piping from the water-filled part, has to be designed with a large air-area opposed to a small water-area so that it is necessary to furnish an air pressure of only one-quarter or one-third the water pressure; the idea is that when a sprinkler head is melted by fire under an air-filled system, the more air there is in the pipe, the longer it takes the water to push it along and reach the fire, a few seconds' times often being of great importance in what is called a quick fire. To this objectionable delay in the use of compressed air there has been added the high first cost of the air-valve, the care needed to keep it in good order, its taking up three or four times as much room as the watermain, and the fact that compressed air is not always available at isolated buildings. Again, an air leak in a piping system is very difficult to find so that electrical alarms and constant watchfulness of the air valve are needed to prevent the air leaking out and water following it up in cold weather, when a freeze-up would be very expensive in itself as well as dangerous in case of a fire at the same time.

The mills in which the writer has had charge of the fire protection make carbonate of soda from salt and limestone, the sodium chloride and calcium carbonate being broken up and reunited into sodium carbonate and calcium chloride, the latter being regarded as a by-product. In solution, calcium chloride is much heavier than water, slow to boil and slow to freeze, strong solutions being able to withstand temperatures as low as 30 degrees below zero. Its general introduction as a non-freezing solution for the water-jackets of automobiles some years ago suggested its use as a substitute for compressed air in exposed automatic sprinkler systems. The insurance companies, when asked for approval of this innovation, raised the question of expansion. The coefficient of calcium chloride is high, so that as the check valve prevents the expansion's finding relief back in the water main, it might send the pressure on the sprinkler system up to bursting point and cause as much damage by water as a fire would. Various arrangements were suggested to take care of this expansion, the most prominent being air-chambers, relief valves, and a U-seal arrangement of the supply main to take the place of the check valve in preventing the heavy calcium chloride from working back into the main. Recent experience in rail welding having shown that the expansion in the rails of street railway tracks has a way of taking care of itself when the rails are laid too close to allow of longitudinal expansion, an experiment was tried with two sprinkler systems, one building being equipped with an expansion air-chamber, and another unimportant building without any expansion device at all. The elaborate air valves were then replaced with simple check valves, and a strong solution of calcium chloride was pumped in. A year's test showed that the expansion took care of itself as in the railroad rails. Evidently a network of small piping has considerable elasticity, which is helped by the trapping of small quantities of air in the piping when being filled with the calcium chloride, and by small leakages back through the check valves, very few of which will not leak a little.

In filling a sprinkler system with calcium chloride on the approach of cold weather, it is first necessary to drain all the fresh water out from above the check valve, as the calcium chloride is so much heavier than water that any water remaining in the pipe will be floated up into the small piping under the higher roofs, where it may freeze before it has had time to combine with the calcium chloride solution. This drainage is done through the customary drip-pipes provided in the air system, where it is even more important to get all the water out of a system before pumping in the air. Again, in very cold buildings, care must be taken to let the air out of the high points of the piping system as the calcium chloride is pumped in. Otherwise, any large quantity of air trapped in the pipes will leak out so slowly as to be unsuspected and thus make room for fresh water to enter through the check valve and possibly for the calcium chloride to pass out. The air is very readily let out through vent cocks or by unscrewing an occasional sprinkler head itself. This precaution is rendered less important from the fact that the check valve is usually placed in the large supply main, which is less liable to freeze than a small pipe, and also has so much calcium chloride in it that fresh water getting through the check valve is taken up in the solution before it can freeze.

This substitute for compressed air has been used for four winters successfully in unheated warehouses in Detroit.

U. S. SEAGOING DREDGES

At the recent annual meeting of the Society of Naval Architests and Marine Engineers Mr. Thomas M. Cornbrooks presented a paper on the seagoing suction dredges built and building for the United States Government. These range in length from 166 to 300 ft., and capacities of bins from 1,000 to 3,000 cu. yd. The latest dredge is the Galveston, which has just been completed at the works of the Maryland Steel Company, Sparrows Point, Md. In operating it, it is kept moving forward, at a speed of six knots per hour, with the suction pumps dragging on the bottom. The material is sucked up by 20-in. centrifugal pumps and discharged through pipes and distributing chutes into the bins. By gates in the bottom and sides of these chutes it is possible to distribute the material evenly. As the bin fills the water is drained off by overflows through the sides. When the bins are full the dredge goes to its dumping ground and the load is discharged by opening the gates in the bottom, which are operated by a double cylinder vertical engine through worms and fixed nut on vertical rods. The dredge is propelled by two compound engines, steam for which is furnished by four single-ended boilers.

COOLING INTAKE AIR

It is possible that one reason why pre-cooling of the supply to air compressors is so seldom done is the dread of the "practical" man in charge that the air may be moistened. Of course, moisture in the air is one of the chief troubles with which users of compressed air have to contend; but by proper arrangement of the cooling apparatus, it should be possible to draw the air into the compressor not only cooler, but dryer than ordinary air. It will be remembered that the capacity of air to hold moisture rapidly falls off as its temperature is reduced. By subjecting the entering air to direct contact with cool water, the moisture will be condensed and caught by the water.—*Exchange.*

Take the air into the compressor as cool as possible, is a rule without any exception that we can think of. It is hardly worth while to consider the moisture that may be in the air when it enters the compressor cylinder. It will make no trouble then. After the air is compressed to the usual working pressure of say 6 or 7 atmospheres, 75 to 90 pounds gage, and is cooled to normal temperature while at that pressure, it is, in our climate, almost sure to be more than saturated with moisture, and if it is given a chance to drop the moisture then there is not likely to be any trouble with the moisture in the air after that. Cooling the intake air is a direct saving of power by reducing the volume to be compressed.

WESTINGHOUSE.

The Westinghouse Electric & Manufacturing Company has again become the property of the stockholders, after having been in the hands of receivers since the 23d of October, 1907. During the year the receivers have been in charge they have not only succeeded in paying off the interest on bonds, as it fell due from time to time, but they have also kept the large factories of the company in operation during the entire time, doing an excellent business at a net profit of over $1,000,000. The action of 5,000 employes in subscribing for $600,000 of stock of the company was a feature presented to the court, which made a great impression, because it demonstrated the amount of confidence the employes themselves had in the company. It was also brought out that the company under the reorganization would in every way be in a better condition than at any previous period in its history, as it would start upon the new regime with cash on hand amounting to upwards of $15,000,000, with an indebtedness of only about $200,000. Mr. Cravath in addressing the court on behalf of the Stockholders' Committee, stated that in the annals of receiverships, this one stood without a parallel as the most successful.

TRADE PUBLICATIONS

Applications of Thermit in Foundry Practice, Goldschmidt Thermit Company, New York, 28 pages 6 by 9 inches. The value of Thermit in foundry work consists in the fact that the high heat of 5,400 degrees F. can be applied anywhere and without apparatus to increase the temperature of iron and steel and facilitate the introduction of other refractory metals. This pamphlet gives interesting and valuable information concerning the application of Thermit in the lines indicated.

Deviation in diamond drilling has been known to be as much as 2185 feet in a depth of 4802 feet.

NOTES

White oak timber in mines will last on the average three years in return air and four years in intake air.

The wholesale trade value of the candy produced in the United States this year will equal $100,000,000, and the cost to the actual consumers will be 30 to 50 millions of dollars more than this.

The latest issue of Mine and Quarry, the quarterly publication of the Sullivan Machinery Company, is an attractive and unusually interesting number. Its *piece de resistance* is a description of the power plant of a large coal mine in Pennsylvania.

The Westinghouse Diary for 1909, its fifth year of publication, is a neat and complete pocketbook, comprising, besides the complete diary, a variety of general data and also more than ever of information concerning the Westinghouse products. Every engineer should want it, and can have it.

Acetylene is being used in Germany as an explosive for blasting purposes. Each cartridge contains slightly less than 2 oz. of calcium carbide. After wetting the carbide the confined mixture of generated gas and air is exploded by an electric spark. Rock, when blasted in this way, is not thrown out, but is broken up into pieces small enough to be readily removed.

The C. & G. Cooper Company, Mt. Vernon, Ohio, is installing two tandem compound steam engines of 3,000 hp. each in the plant of the American Steel & Wire Company at Braddock, Pa., and is also installing two 4,000 hp. and one 2,500 hp. tandem compound engines in the rail mill of the Edgar Thomson Works of the Carnegie Steel Company at Bessemer, Pa.

The United Iron Works, Spokane, Washington, have succeeded the Bradley Engineering Company as agents for the Sullivan Machinery Company. They also represent the Sullivan Machinery Company at Seattle. Mr. Austin Y. Hoy is the personal representative of the Sullivan Company, with headquarters at Spokane.

At the Spokane fair rock drilling contest two miners of the Butte camp broke all records in hand drilling by drilling 56⅝ inches into solid granite in 15 minutes. Five years ago a record of 55 inches was made. The miners displayed wonderful skill in changing drills, the changes being made without the loss of a single stroke.

A demonstration of the Menne oxygen torch for opening tuyeres took place at Pottstown, Pa., recently at the works of the Warwick Iron & Steel Company. It happened that one of the tuyeres was closed. It was quickly restored. The method has also been shown at the plant of the Lackawanna Steel Company at Buffalo. Since oxygen is now being made on a commercial scale in this country the Menne process is likely to be widely adopted.

An ozone plant for purifying the water supply has been installed at Lindsay, Ontario. The water comes in part from swamps and also is exposed to sewage pollution. It passes through a roughing filter containing 3 ft. of coarse sand before entering the ozonizing tower, which is about 30 ft. high. Here it passes down a number of vertical 4-in. tile pipe into which the ozonized air is delivered by brass pipes.

The United States Steel Corporation is to establish a bureau of its own for scientific research. It is to have a special building with complete and independent equipment at the Duquesne works near Pittsburg. The first head of the bureau will be John S. Unger, now assistant general manager of the Homestead works. While research has been carried on by the various constituent companies the object is to make investigation more systematic and thorough for the benefit of the entire organization.

It has been found impossible until quite recently to remove the last traces of impurities, especially sulphur and phosphorous, from iron and to produce it chemically pure. A German chemist, Dr. H. Kreusler, by a long series of ingenious processes, partly chemical and partly electrical, has at last succeeded in isolating the pure metal, the properties of which differ greatly from those of the familiar, impure metal. Iron prepared by Kreusler's process resembles platinum, and perhaps costs nearly as much.

At the Lance Colliery of the Lehigh and Wilkesbarre Coal Company at Plymouth, Pa., recently the throttle of the hoisting engine stuck while hoisting a miner in the cage. Finding he could not stop the engine the engineer reversed when the cage was near the top and again when near the bottom, so that the occupant was shot up and down at full speed over and over again. The engineer kept blowing the whistle and finally other employes succeeded in shutting off the steam, with both the engineer and the miner near total collapse.

About three years ago Mine No. 4 of the Berwind-White Coal Mining Company, at Valier, Pa., filled with water during a temporary suspension of operation. Two large pumps were installed last May, and kept in continuous operation until about the middle of October, the capacity of the pumps being respectively 200 and 587 gallons per minute. They reduced the water at the rate of 1,133,280 gallons per day, the total number of gallons of water taken from the mine from May to October 15 being 186,981,200, and the mine is again ready for operation.

The most congested street crossing in New York is at 42nd Street and Fifth Avenue, the traffic being enormous upon both thoroughfares and practically continuous for at least twelve hours of the day. As a means of relief it is now proposed to have a depression in 42nd Street thirty-two feet wide with thirty-six feet at Fifth Avenue. In this depression the surface cars and heavy vehicles will be operated. At the side of the street on the usual grade light vehicles will cross. Fifth Avenue will intersect by a viaduct over the depression, and a bridge of ornamental construction will be built.

There died in Glasgow recently Thomas Wilson, mechanical engineer of the Caledonian Railway Company on the Forth and Clyde Canal, whose grandfather, bearing the same name, and then a carpenter-mechanic in the employ of the Forth and Clyde Canal Company constructed for that company the first iron vessel in regular service in Scotland. This was the Vulcan, launched May 14, 1819. She was 61 ft. long, 11 ft. beam, and 4 ft. 6 in. deep, and was built of plates and flat bar frames, the framing and stanchions being forged wholly on the anvil by hand labor. The Vulcan commenced plying on the canal in 1819 and was in service as recently as somewhere in the seventies.

The introduction of vanadium renders steel very mild when annealed, and very hard when tempered. Armor plates can be produced of vanadium steel with an extremely hard outer surface and with a soft backing. The superior ductility of the soft backing of vanadium steel would avert the splintering of hardened plates and shields when struck by projectiles. The point of greatest importance in connection with the use of vanadium steel on armored vessels is, that it will be possible either to reduce the present thickness and weight of plates while preserving the same protective power, or to increase the protection by at least 90 per cent. by retaining the same weight and thickness.

Definite plans and proposals are being considered for a system of electric and pneumatic despatch tubes for the distribution of freight in New York City. The project as urged by Representative Charles N. Fowler, of New Jersey, is similar to one recently proposed by the Amsterdam Corporation except that the cars are much smaller, and the system contemplates not only the transportation of freight from the railroads in New Jersey to New York warehouses, but delivery also to retail stores and parcels to apartment houses and hotels. It is urged for the system that it would save the city annually $5,000,000 in paving and street repairs, $3,000,000 in the removal of waste and would practically do away with horses for heavy trucking.

Six men lost their lives by suffocation in a salt mine shaft near Detroit on Nov. 28. A contracting company has been engaged in sinking a shaft to be 880 feet deep for the Detroit Salt Company. The six men were at work excavating 500 feet down in the shaft. Their supply of air came from a two-foot canvas tube, which ran down the shaft from the surface of the ground. In some unexplained manner this tube became either tangled or clogged about 200 feet down from the surface. With the air supply shut off, the shaft rapidly filled with gas, hydrogen sulphide, and the men were suffocated. It was some time before the rescuers from the surface could reach them, and then they were at first able to extricate only four of the bodies.

The North Dakota, our biggest battleship, lately launched, is 510 feet long or 60 feet longer than the Connecticut. Her displacement is 20,000 tons which is 1,000 tons in excess of the largest vessels of the British Dreadnought type. The most striking feature of this battleship is the "spider" masts, so constructed as to be hard to cut down with shots, and thus making it possible to keep lookouts up in the air at critical moments. The North Dakota is called more massive in armament, swifter in speed and stronger than the best of the British monsters, the apparent fate of all being to rust into uselessness or to be superseded by still more formidable craft. When we last figured up the cost of a warship it came to 25 cents a pound, Corliss engines at the same time costing 3 cents or less.

Carbide when pure will yield from 5.5 to 5.8 cubic feet per pound. Between 4.25 and 4.75 cubic feet is the average yield from the commercial product. The relative quantities, by weight, of water and carbide necessary to form acetylene and dry slaked lime are 36 parts of water and 64 parts of carbide, which yield 26 parts of acetylene and 74 parts of slaked lime. Water will, therefore, theoretically decompose nearly twice its weight of carbide, but in practice, in a good generator, about 17 times this quantity is used. The reason for this is that the decomposition of carbide and water into acetylene and lime liberates heat. The quantity liberated from good carbide is 730.73 B.T.U. per pound of carbide. One pound of carbide will raise the temperature of 8⅓ lb. (one gallon) of water about 87 degrees F.

The members of the trades unions employed in the shipbuilding plant of Furness, Withy & Co., Hartlepool, England, voted November 4, at the rate of 10 to 1, to give a year's trial to Sir Christopher Furness' profit-sharing proposition. The thousands of employees in the Hartlepool plant will buy stock in the concern immediately, on which they will receive a 4 per cent. dividend, whether the company has a surplus at the end of the year or not. The stock will be paid for by a 5 per cent. deduction from wages, until the indebtedness is cleared. The venture is said to be the largest profit-sharing scheme ever attempted. In the agreement between Sir Christopher and the unions a pledge by the men against future strikes is exacted. All disputes and differences will be left to a work's council, composed of an equal number of officials and workmen.

LATEST U. S. PATENTS

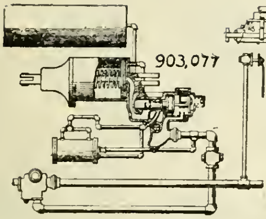
Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D C. .

NOVEMBER 3.

902,605. APPARATUS FOR CENTRIFUGAL FLUID COMPRESSION. Sidney A. Reeve, Worcester, Mass.
902,620. PNEUMATIC NAIL DRIVER. Scott B. Stewart, Augusta, Me.
902,622. HUMIDIFIER. Charles Subert, Chicago, Ill.
902,637. FLUID-PRESSURE SYSTEM. Bert Aikman, Chicago, Ill.
902,693. INDICATING DEVICE FOR USE WITH PNEUMATIC TIRES. Thomas Sloper and Robert Sloper, Devizes, England.
902,835. AIR MOISTENER AND EVAPORATOR. Oscar R. Rice, New York, N. Y.
902,836. FLUID - PRESSURE - OPERATED DRILL. Andrew F. Ross, Long Island, N. Y.
902,841. PNEUMATIC STACKER. Joseph K. Sharpe, Jr., Indianapolis, Ind.
902,842. FAN FOR PNEUMATIC STACKERS. Joseph K. Sharpe, Jr., Indianapolis, Ind.
902,905. HUMIDIFIER FOR RADIATORS. George J. Palmer, West Chester, Pa.
903,077. AIR-BRAKE. William P. Gentleman, Beatrice, Nebr.
903,122. AIR-PURIFYING DEVICE FOR AUTOMOBILES. Herman E. Whit|&7, Palmyra, N. Y.
903,150. METHOD FOR PURIFYING AND HUMIDIFYING AIR. William *G. R.* Braemer, Buffalo, N. Y.

NOVEMBER 10.

903,264. FLUID-ACTUATED ENGINE. Edwin J. Armstrong, Erie, Pa.
903,298. PNEUMATIC BUTTER-SEPARATOR. La Fyette Lillard, Bootjack, Cal.
903,325. REDUCING-VALVE FOR COMPRESSED - FLUID MOTORS. Eugene Schneider, Le Creusot, France.
903,379. AIR-BRAKE. William R. Heironimus, Evansville, Ill. ffl ffl ffl ffl ffl ffl
903,405. MEANS FOR PREVENTING DOUBLE EXPOSURES. Percy F. Rice, Tustin, Cal.
903,420. HYDRAULIC COMPRESSOR. Louis E. L. Themke, Strathcona, and Samuel McCardia, Edmonton, Alberta, Canada.
903,543. AIR-PUMP. Alphonso S. Comstock, Evanston, Ill.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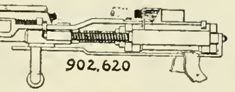
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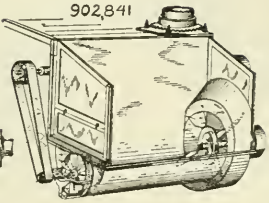
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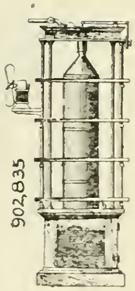
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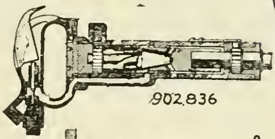
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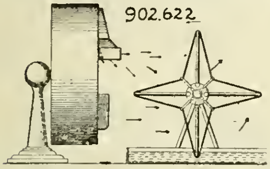
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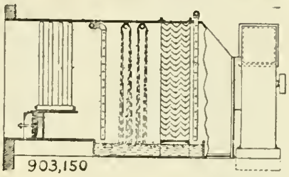
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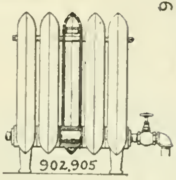
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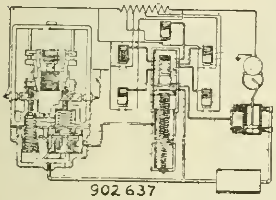
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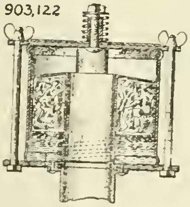
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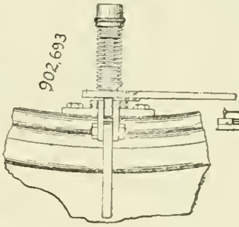
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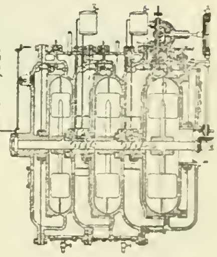

902,605

Pneumatic Patents, November 3.

903,646. AIR-INJECTOR. Erich Werwath, Linden, near Hanover, Germany.

03,660. AIR-PRESSURE SYSTEM FOR TURRETS AND THE LIKE. Herman Bensch, New York, N. Y.

NOVEMBER 17.

903,892. FLUID-PRESSURE SYSTEM. William F. Schneider, Norwood, Ohio, assignor to Allis-Chalmers.

903,921. DUMPING-CAR. Munson H. Treadwell, New York, N. Y., and Carl P. Astrom, East Orange, N. J.

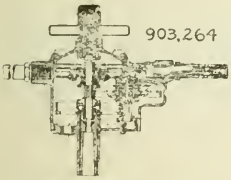
904,219. AIR-COMPRESSOR, &c. Isaac Patrick, New York, N. Y.

904,294. AIR COMPRESSOR. Harr E. Bailey, Albany, N. Y.

904,322. PNEUMATIC HORSE-COLLAR. Alexander J. Fike and Charles M. Fike, Clifton Mills, W. Va.

904,371. SPRAYING DEVICE. John W. Stewart, Martinsburg, W. Va.

904,414. PNEUMATIC - CARRIER SYSTEM. William H. Earl, New Orleans, La.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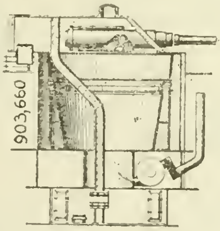
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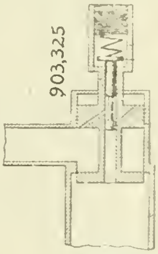
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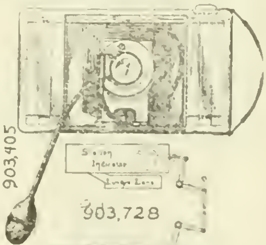
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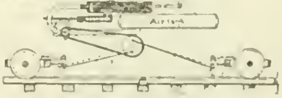
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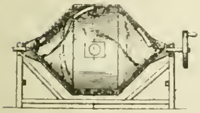
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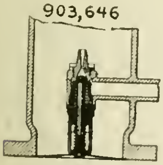
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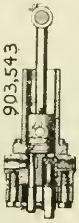
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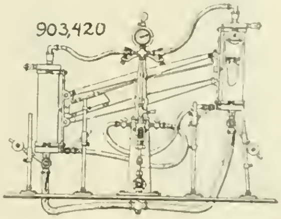
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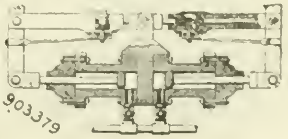
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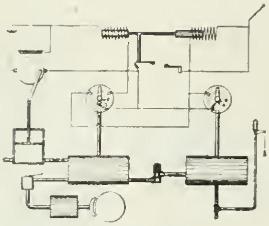
Pneumatic Patents, November 10.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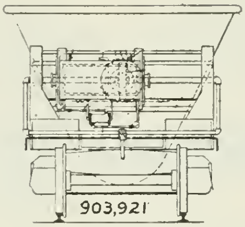
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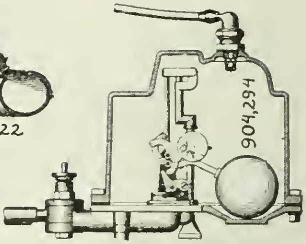
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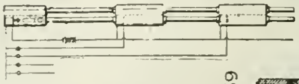

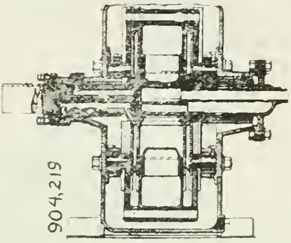
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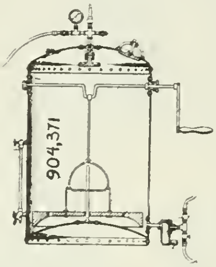
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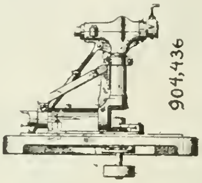
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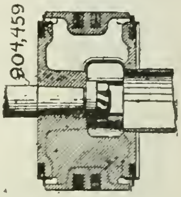

904,459

Pneumatic Patents, November 17.

904,436. ROCK-DRILL. John H. Huhn, Fairmont, W. Va.

904,459. PISTON INLET-VALVE. Henry C. Sergeant, Westfield, N. J., assignor to the Ingersoll-Rand Co.

NOVEMBER 24.

904,507. AIR-GUN. William J. Burrows, Plymouth, Mich.

904-568. AIR-BRAKE INDICATOR. Orie R. Snyder, Knoxville. Tenn.

904,724. IMPACT-TOOL. Charles B. Richards, Cleveland, Ohio.

904,725. IMPACA-TOOL. Charles B. Richards, Cleveland, Ohio.

904,726. IMPACT-TOOL. Charles B. Richards, Cleveland, Ohio.

904,827. PNEUMATIC IMPACT-TOOL. George L. Badger, Quincy, Mass.

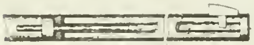
904,930. AERIAL SHIP. Franz Bollhorn, Veddel, near Hamburg, Germany.

904,940. AIR-COMPRESING PUMP. Sven Dahlberg, Springfield, Mass.

904,967. PNEUMATIC RECUPERATOR FOR RECOIL-GUNS. Nobert Koch, Essen-on-the-Ruhr, Germany.

904,975. AUTOMATIC GLASS-MOLDING APPARATUS. Francis J. Mackin, San Francisco, Cal.

905,009. BRAZIER'S LAMP. James A. Shores, Crowder, Okla.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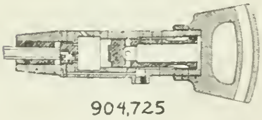
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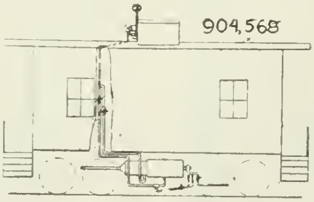
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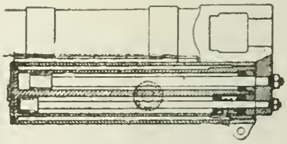
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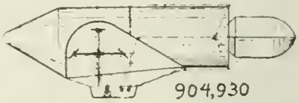
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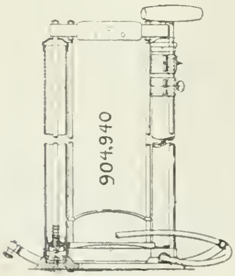
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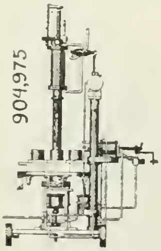
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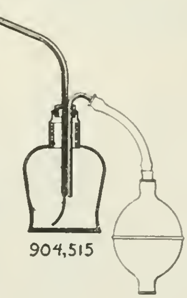
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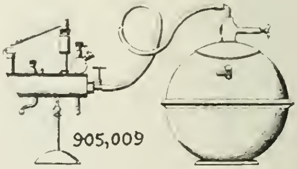
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RAPID METHODS IN DRIVING ALPINE TUNNELS

By Walter I. Aims.*

Records of speed attained in driving rock tunnel headings show that the progress made in Alpine tunnels has far exceeded the best American records, and it therefore becomes a matter of considerable importance to determine the reasons why so great a difference should exist.

The best American record is now claimed for the Elizabeth Lake tunnel of the Los Angeles aqueduct work, where 466 feet is said to have been driven in a single heading during October, 1908. But even this record falls far short of that made at the Simplon tunnel in the Alps, where 685 feet was driven in one heading during July, 1904.

The writer has recently visited the Loetschberg tunnel now being built between Kandersteg and Goppenstein near the line of the Gemmi Pass, Switzerland. It is on the line of the railway to connect Berne with the Simplon tunnel road to Italy. In this tunnel similar monthly progress to that made at the Simplon is now being accomplished, and the results of the writer's observations are herewith appended.

This tunnel when completed will be about 8½ miles long. Near the northern portal the tunnel passes under the Kander River and it is at this point that the serious cave-in, extending up to the river bed, occurred last July. This accident occasioned the temporary abandonment of work in that heading until plans shall have been decided upon for meeting this difficulty. The work, therefore, is at present being carried on from the southern portal only.

The experience gained in driving the Simplon tunnel is being used to advantage at the Loetschberg, with the difference, however, that while the Simplon was driven with rotary drills of foreign manufacture, the Loetschberg is being driven with American air driven percussion drills made by the Ingersoll-Rand Company.

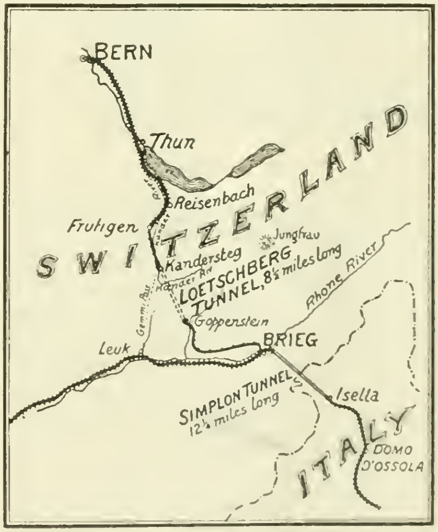

FIG. 1.—LOCATION OF TUNNEL.

The tunnel is designed for a double track railway and has a cross-sectional area of about 66 square yards. The bottom heading method of construction can therefore be used to advantage. This bottom heading is about 6 feet 6 inches high by 10 feet wide. Every 600 feet upraises are made from the bottom heading and a top heading started from each of these upraises. From these top headings the work of taking out the tunnel to its full section is carried on in bench work, timbering being erected in the bottom heading during the later stages to prevent the shell of rock between the top workings and the bottom heading breaking through and thus blocking the track below. As soon as these top excavations are connected with the bottom heading the timbering is removed to be used again at another point. The sides are then trimmed out and the concrete lining is placed, largely made up of beton or concrete blocks backed with concrete.

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*45 Broadway, N. Y.

There is but a single track in the bottom heading about 2 feet 6 inches gage, with turnouts every 600 feet where the upraises occur, the bottom heading being widened out at these points to accommodate the turnouts. Numerous chutes about 2 feet square are also blasted out between the bottom heading and the top workings through which the muck is dumped into the trains of cars in the bottom heading.

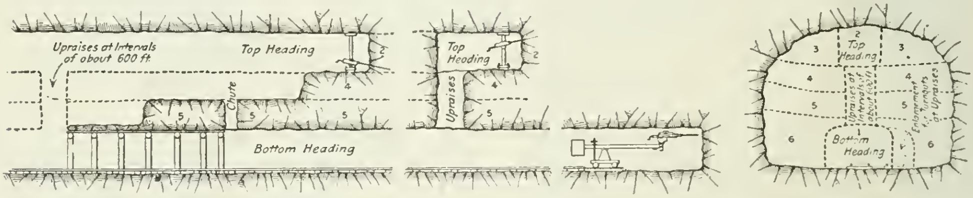
Upraises at Intervals of about 600 ft.
Top Heading
2
4
Chute
5
5
5
Bottom Heading
Top Heading
2
Upraises
4
5
3
2
Top Heading
3
4
Upraises at Intervals of about 600 ft
4
Enlargement for Turnouts at Upraises
5
5
6
1
Bottom Heading
6

FIG. II.—METHOD OF ATTACK AND SEQUENCE OF OPERATIONS.

By this method of working, there is no difficulty in keeping pace with the heading, and in taking out the full tunnel section; at the same time no delay is occasioned to the heading operations. The speed of the heading, therefore, is the speed of the completed tunnel and hence it is the methods used at the heading upon which the main interest centers.

The secret of the great speed in these Alpine tunnel headings appears to be that a very careful study has been made of the various causes of delay in the successive operations of drilling, blasting, mucking out, and setting up the drills again, with the result that a radically different method of mounting the drills in the heading has been employed and also that a different system of blasting is used from that practiced in America.

In the mounting of the drills, the return to the old drill-carriage idea is disclosed; but in this instance there is no such cumbersome affair as the drill carriage used in the early tunneling operations in this country.

The drill carriage at the Loetschberg simply consists of a small truck with a wheel base of about 4 feet running on a regular heading truck. Mounted on this truck and hinged to swing vertically, is an I-beam reinforced to give it lateral stiffess. On the forward end of the I-beam there is mounted what we in America would call a shaft bar, pivoted to swing horizontally. On the opposite end of the I-beam is a counter-weight. Four drills ("F. 94") are mounted on this shaft bar, the compressed air connections from these drills running back to one hose connection at the rear of the truck. The accompanying cut illustrates the main features of the drill carriage. When not in use the shaft bar is swung so that it lies directly over the I-beam, and the carriage can then be run anywhere over the heading tracks, occupying no more room in the heading than a couple of muck cars.

Before blasting a plate of steel about 6 feet 6 inches long, 3 feet 3 inches wide and ⅜ inches in thickness is laid down just ahead of the end of the track. After the blasting is over, a cut is quickly made through the center of the muck pile down to this steel plate sufficiently wide to allow the arm of the drill carriage to introduce the bar carrying the drills into the top of the heading, the drill carriage running on the steel plate laid down ahead of the track. The bar is then firmly jacked against the sides of the heading and drilling immediately begins on the top holes. Mucking out then continues during the drilling.

On account of the drills remaining on the drill carriage at all times with the air connections at the drill undisturbed, there is little chance for dirt and grit to get into the working parts of the drill and so impair its efficiency. The drills are of large size, having a piston diameter of 3-⅝ inches and are designated in the catalog of the manufacturer as "F-94".

There are from 2 to 4 holes drilled in each round for taking out the heading. These holes have a depth of 4 feet and are 2 inches in diameter at the bottom. They are arranged in four vertical rows, the two center rows corresponding to our center cut and two outer rows to the side round. The two center rows, however, are not pointed to form a V as is the custom in America, but are run in more nearly perpendicular to the face.

The rock so far encountered varies from granite to gneiss and is hard drilling. The compressed air for the drills is furnished by two Ingersoll-Rand compressors of the cross-compound two stage type, electrically driven and giving a pressure of from 90 to 100 pounds per square inch at the drills.

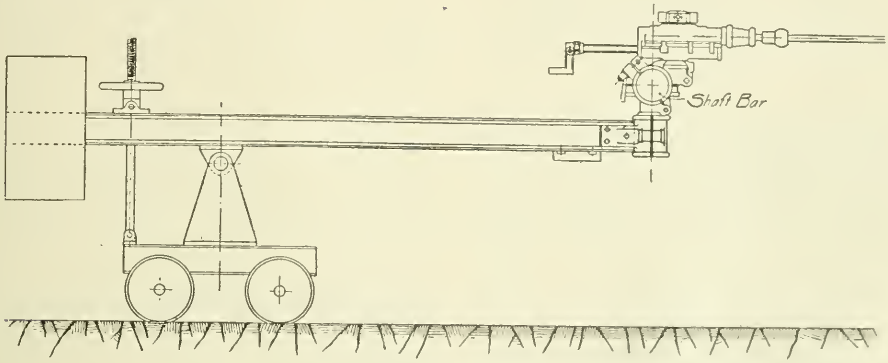

FIG. III.—DRILL CARRIAGE USED IN HEADING.

As soon as the round is all drilled, the drill carriage bearing the four drills is run back to the last turnout and blasting begins. Blasting at the Loetschberg tunnel is done by the fuse-and-cap method of exploding the charge. All of the holes are loaded and the fuses of all of them are ignited at the same time, but by a careful regulation of the length of these fuses a series of minor explosions occurs, so arranged that all of the center holes are exploded before the side holes.

More powder must necessarily be used in firing in this manner, but the advantages gained are as follows: less time is consumed in blasting; the rock is broken up more uniformly; and the effect of the blasting is less severe on the track than when the system of electrical firing is employed. There is one drawback to this method of firing by fuse-and-cap, *viz.*, the danger arising from missed holes. An attempt is made to minimize this danger by employing two fuses in all holes except those at the bottom, where three fuses are introduced.

It would seem that an electrically fired time exploder would fill a long felt want, but while several attempts have been made to manufacture such an exploder, nothing of the kind has as yet been devised that has proved to be a practical success.

The work at the Loetschberg is carried on in three 8-hour shifts and each shift is expected to drill two rounds and to shoot twice, making about 7 feet per shift, or 21 feet per day. A liberal bonus is paid to the men for all speed made above a certain rate. The workmen are Italians, nearly all from the Northern provinces. The following table gives the approximate time for the various operations in the heading:

Setting up drill carriage in the heading	20	minutes
Drilling 12 or 14 holes	60	"
Removing drill carriage from the heading	20	"
Loading and firing the holes	30	"
Clearing out the smoke	20	"
Making cut through center of muck pile for carriage	90	"
Total	240	minutes or 4 hours

Ventilation is provided by means of a large fan, capable of running either as an exhauster or as a blower. From this fan a spiral riveted pipe 2 feet in diameter runs through the bottom heading. The tunnel is lighted with acetylene lamps carried by the miners. Each man is required to buy his own lamp and to keep it in good working order. The light is brilliant and always at the point where it is wanted; and there are no delays such as those arising from broken or disarranged wires where electric lighting is employed.

The difference between the methods used at the Loetschberg tunnel and those employed at home are most striking and interesting. Perhaps when the time comes for Americans to break away from the present established methods in driving rock tunnel headings, improvements and new ideas may enable us to equal and even to exceed the records made in Alpine tunneling.

WHY NOXIOUS WEEDS ARE DESTROYED BY CHEMICAL SPRAYS

By Prof. E. W. Olive, South Dakota State College.

During the past summer the writer carried on experiments with weed spraying in various parts of South Dakota, and to him one of the most interesting problems connected with the work has been that which concerned the way in which the chemical affected the sprayed plants.

I will attempt to describe briefly just why it is that, while mustard and most other common weeds are totally destroyed by the chemical solution, the wheat, oats, barley, flax, etc., are themselves but little if at all injured. This may sound almost like a patent medicine advertisement, but it is nevertheless true that the grain soon recovers from the effects of the treatment, while the weeds, on the other hand, are nearly all killed.

The method of applying the solution for weed killing in grain fields is already familiar to many. The field is carefully gone over with a traction spraying machine, and thoroughly treated with a strong solution of iron sulphate (about 20 per cent., or one sack of about 100 pounds to a barrel of water). The machine which gave the best satisfaction in our experiments covered a swath about twenty-five feet wide, and threw a very fine and powerful spray, under a pressure of from 80 to 120 pounds, directly down on to the young mustard and grain. Practically that amount of pressure is necessary in order to develop the proper fineness of spray as the solution is vented from the nozzle.

As has been borne out by the experiments in other states, the spraying is most effective if done when the grain and weeds are from 6 to 10 inches high; or just before the mustard plants begin to bloom. Also, it is highly important that the work be done during favorable weather. The necessity for this will be understood when we come to consider the physiological reasons for the killing of the weeds. The time when the most successful work is done is just after the dew is off, on a bright, sunshiny day. A little wind will also help the drying process; but if a rain follows too soon, the iron salt is washed off and all the work comes to naught.

Now, if we keep close watch of the sprayed weeds, we can readily follow the various steps of the destructive action of the salt. First, the sulphate dries on the leaves, leaving minute whitish flakes on the surface. This quick drying is apparently an absolutely necessary step in the process; if the day be cloudy, or if through other unfavorable conditions evaporation from the leaf surface is prevented, the weeds may not be killed at all, or at least only partially destroyed.

The next step may be noticed in about two or three hours. If we now examine such succulent plants as mustard, we see on close examination that the leaves show many scattered, more or less translucent, sunken areas, some as much as a quarter of an inch in diameter, other quite small. The leaves by this time appear to be somewhat wilted, and the whole plant looks sick.

Two or three hours later comes the next change. The sunken areas have by this time nearly all turned black, and if these spots are examined through a microscope, it is seen that it is the contents of the shrunken cells which turn black. The leaves from now on wilt rapidly and dry up, so that in twenty-four hours or so they seem to be about dead. In from a few days to a week, most of the mustard leaves fall off, or else remain as dry, withered remnants on the dead stems.

Occasionally a leaf may make a weak attempt at revival; or a plant here and there may make a futile effort at flowering and seed production. But if the work be thoroughly done, few weeds survive the treatment. I have seen mustard so thick as to approximate 100 plants to the square foot, all totally destroyed by spraying.

From the above description of the various steps in the dissolution of a sprayed leaf, the interpretation of the physiological action of the sulphate seems clear. The main process involved seems to be that the water in the leaf is drawn out of the cells by the flakes of salt dried on the surface. Common salt, when sprayed on mustard, ragweed, or most other weeds, in the form of a very strong solution, apparently acts in a manner precisely like that noticed as a result of spraying with sulphate of iron, only its action is even quicker. Of course the plants are going to wilt and die if practically all the water is drawn out of their leaves. The subsequent blackening probably comes from the formation of sulphides in the cells of the leaves, due to the union of some of the absorbed iron sulphate with the living substance.

Now the most interesting question of all remains to be answered: Why are the weeds killed and the grain uninjured? Anyone may answer this question for himself if he will only examine a sprayed field closely, a few days after the spraying has been done. It will be seen, of course, that the grain does not entirely escape injury. The tips of the young leaves are nearly all blackened and killed; but it will be remembered that, when the grain is only six inches to a foot in height, the bases of most of the leaves are well protected, enwrapped within the sheaths and lower leaves. Therefore the spray strikes only a small part of each leaf.

While the grasses and grains thus suffer a little setback, they soon pick up again. They owe their freedom from permanent injury, undoubtedly, to their habit of indeterminate growth, as well perhaps as to the fact that their smooth surfaces shed the water. The minute droplets of the iron sulphate or salt do not adhere readily to the surface of flax, for example, on account of the waxy bloom which covers the plants; and many other grains (and some weeds, too, for that matter) are likewise provided with such a protective covering.

The highest mine in the world is the Santa Barbara, Bolivia, South America, which is at an altitude of 18,000 ft. above sea level.

PRACTICAL HYGROMETRY

By J. H. Hart.

[The following is presented, in a more or less condensed form, from the columns of *Power and the Engineer*].

The wonderful adaptation of mechanical refrigeration in the removal of moisture from the blast in iron furnace operation, and its consideration in the operating of cooling towers, and also the possible application of mechanical refrigeration to the drying of blasts of any kind and wherever used, have brought the subject of moisture in the atmosphere to the notice of the practical engineer.

Hygrometry determines the quantity, always variable, of aqueous vapor in the air. The atmosphere is seldom, if ever, completely saturated with vapor, and never completely dry. The ratio of the quantity of acqueous vapor actually present in the air to that which it would contain if saturated, the temperature being the same, is called the hygrometric state, or the degree of saturation.

ABSOLUTE MOISTURE IN THE AIR AND ITS VARIATIONS.

The absolute moisture in the air is the weight of water actually present in the form of vapor in the unit of volume. There is this remarkable fact about vapors in general. Two vapors, or a vapor and a gas, will occupy the same place just as if the other were not present. [That is, each will occupy its own amount of space independently of the amount of space occupied by the other. Ed. C. A.] Thus water vapor is present everywhere in the space surrounding the earth, and the quantity of this vapor depends simply upon the temperature of the vapor and its contiguity to a source of the liquid. If immediately in contact, it in general becomes saturated for that temperature in precisely the manner that steam becomes saturated in a boiler, and remains so. A saturated vapor in this department has the same significance as a saturated vapor in steam or ammonia work. It means that if the pressure is increased or the temperature lowered, condensation occurs, or in other words, that the space contains all of the vapor possible at that pressure and temperature. Thus the space surrounding the earth contains water vapor independent of the quantity of air present.

Absolute moisture in the air varies with the temperature in the course both of the year and of the day. If summer, there is a maximum in the morning and evening and a minimum at 3 a. m. and 3 p. m., because of the ascending current of air which carries the moisture upward. The absolute moisture is greatest in the Tropics, where it represents a pressure of 1 inch of mercury, while in our latitude it does not exceed 0.4 inch. The relative moisture, however, is on the average greater in high than low latitudes. It is at its minimum in the hottest and at its maximum in the coolest part of the day. It varies in different regions, and is greater at a distance from a large body of water than when near at hand. Thus in England the relative moisture is about 80, in Italy about 60 and in Siberia about 40 per cent. When the air is cooled, the relative moisture increases until it ultimately becomes saturated. This accounts for the production of rain and dew and snow. They are invariably due to the cooling of the atmosphere below the saturation point of the aqueous vapor present.

SENSIBLE HUMIDITY.

Our judgment in regard to relative humidity varies greatly. In summer we say that the air is very dry when it contains an average of 1/40 of a pound of water to the cubic yard, as it could then contain twice this amount without condensation. On the other hand, in winter if the same volume contains 1/80 of a pound, we say it is very moist, because it is very near the saturation point and a very slight diminution in temperature produces a deposit. When a room is warmed, the quantity of moisture is not diminished, but the humidity of the air is lessened, because its saturation value is raised. The air may thus become so dry as to be injurious to the health, and hence arises the precaution of placing vessels of water in such a room.

RATIO OF PRESSURES RATHER THAN QUANTITIES.

Boyle's Law applies to non-saturated vapors as well as to gases, and the presence of another gas or vapor has no effect on the operation of this law. Hence, it follows that, with the same temperature and volume, the weight of vapor in an unsaturated space increases with the pressure and, therefore, with the pressure of the vapor itself. Instead, therefore, of using the definition of hygrometric state as the ratio of the quantity of vapor present to the quantity of vapor present in a saturated state, it can be defined as the ratio of the pressure of the vapor which the air actually contains and the pressure of the vapor which it would contain at the same temperature if it were saturated. Thus if f is the actual pressure of the aqueous vapor in the air, F that of the saturated vapor at the same temperature and N the hygrometric state, we have

$$N = \frac{f}{F},$$

whence

$$f = F\,N.$$

As a consequence of this second definition, it is important to notice that, the temperature having varied, the air may contain the same quantity of vapor and yet not have the same hygrometric state, for when the temperature rises, the pressure of the vapor which the air would contain if saturated, increases more rapidly than the vapor actually present in the atmosphere, and hence the relation between the two forces, or the hygrometric state, becomes smaller.

RELATIVE HUMIDITY.

PRESSURE, TEMPERATURE AND CONDENSATION.

This relation N is what is generally measured in the majority of hygrometers. Given this value and the pressure and temperature obtainable from other sources, the absolute moisture in the air, or the quantity of water present, can be calculated by suitable formulas. The absolute quantity of water present in the air can also be attained directly by what is known as a chemical hygrometer. This consists of some hygroscopic substance which is weighed and then made to absorb all the moisture in a certain quantity of air. It is then reweighed and the quantity of moisture obtained by subtracting. This gives abolute values, and is the only thing of much importance in refrigeration work in the removal of moisture from the air. The only necessary factors to consider in a problem of this kind are: The quantity of air which must be furnished, the quantity of moisture that it contains and the temperature to which both must be cooled in order to condense moisture.

It is obviously impossible to cool the air to a sufficent extent to remove all the moisture if no limitations of pressure are considered, but in practice, with suitable pressures and temperatures, it is possible to condense almost the entire amount. The amount condensed for a given temperature depends primarily upon the pressure, and thus, in different applications of blast operation, different cooling temperatures must be maintained. The removal of the moisture from the air blast in iron-furnace operation increases the production of the iron, on account of the saving in heat and its concentration in the furnace. Water vapor has a high specific heat and, when injected into the furnace, absorbs large quantities of heat in its passage. Further, a process analogous to that in the production of water gas goes on and the water vapor present at this high temperature is decomposed with the subsequent loss in the furnace of its heat of decomposition. This decomposed material unites with carbon partially and goes on into the exhaust, where it gives up its heat by recombination and further increases the heat waste in the exhaust. It is analogous in this respect to the nitrogen present in the air, but is tenfold as destructive in its effect. The cooling of the air is lost in the furnace, since the air must be reheated, and further, the degree of cooling affects the efficiency of the refrigerating device; hence, all of these factors must be considered in determining the degree to which air must be cooled, and no fixed values can be given. Sufficent data are not at hand and results can only be obtained from practice.

BEHAVIOR OF WATER VAPOR IN AIR.

Of course it goes without saying that air can be cooled more efficiently from a practical point of view when under pressure, and the process of removal of the moisture continued more efficiently; but the behavior of the water vapor during compression of the air is an important factor and also enters to disturb results for best efficiency. The best method of considering the behavior of water vapor in air and its effect on efficiency, is to regard it separately in all its changes. Thus when air is compressed and has water vapor in it, we can get the best conception of the results by regarding each material as separated and the process performed in this state followed by a recombination. Thus water vapor, if separated and compressed, will condense partially, if not heated at the same time, and a consideration of the phenomena that occur under these conditions shows results exactly similar to those holding in steam work. In general, with increase in pressure on a condensable vapor at its saturation point, there results a considerable condensation which gives out its heat of liquefaction. If air is compressed, the work done in it heats it somewhat, and the presence of water vapor, also compressed, heats it still more on account of the condensation of the water. The mixture of water vapor and air may be heated to such an extent as almost to evaporate the water again, but the general result is to increase the working pressure of compression, thus diminishing the efficiency of the plant.

AIR A CONVENIENT CARRIER FOR WATER VAPOR.

In general, the whole phenomenon of moisture in air and its application can be best considered by regarding the moisture as occupying the space independently of the air present. Thus in cooling towers and drying devices of all kinds, advantage is taken of the fact that an unsaturated vapor tends to become saturated when immediately in contact with a liquid of its own substance, and tends to remain so. In cooling-tower work we can neglect the presence of the air and regard the space surrounding the cooling tower as filled with water vapor, in a more or less saturated condition. The presence of the air is an advantage from a mechanical point of view, simply by furnishing a convenient carrier for the water vapor, or by offering something by which the water vapor can be conveniently held and moved, so that the efficiency of a cooling tower depends absolutely on the quantity of saturated vapor which can be brought into immediate contact with the water, and this depends, within certain limitations, upon the quantity of air which can be brought under the same conditions and upon the surface of the water to be cooled. A great mistake is often made in cooling-tower practice by using fans to drive the air rapidly through the entire length of the tower. The air is merely a conveyor of the unsaturated water vapor. This becomes saturated almost immediately upon contact with the first layer of water in the tower and the further progress of this saturated vapor, and the air which drives it, is a distinct economic loss in the operation of the plant.

WARM AIR FOR COOLING TOWER.

Today it is generally recognized that atmospheric cooling towers are much superior, from an efficiency point of view, to those operated by fans. A mistake is often made in this practice by not considering the temperature of the substances involved. Unsaturated water vapor which has been heated requires a greater additional quantity of water to make it saturated. Hence it is much better to use warm air in a cooling tower than cold, anomalous as this statement may appear. The cold air does cool off the hot water to a certain extent by conduction and contact with its surface, but air is notoriously a poor conductor, and hence the advantage derived from this factor is very small. Hot air means that the water vapor is hot also and less saturated than before, if such a term can be used, and the relative humidity N, is much less. This is a point which should not be lost sight of in cooling-tower work, or drying work of any kind, and modern practice seems to bear out this statement.

The utilization of superheated steam as a drying agent is a distinct example of this development. Superheated steam, although very hot when allowed to go over moist materials, rapidly absorbs the water from them and actually cools them below their former temperature, although the amount is nowhere near as great as in cooling-tower practice, since the water vapor in contact is a fairly good conductor of heat.

PRESSURE AND GAGE CONDITIONS

"The trouble with me is that I know too darn much," drawled the puzzle editor as the chief passed his desk.

"How so?"

"Didn't you ever notice that the less a man knows about a thing the quicker he can give you an answer about it? For instance, here is a fellow who wants to know what is the difference between the gage pressure and the absolute pressure. I was on the point of telling him 15 pounds. If your gage pressure is 75 pounds, the absolute pressure is $75+15=90$ pounds. That is good enough for most cases, and more exact than men ordinarily read gages or than gages usually are, but I happened to think that the fellow may use Kent's table, where the gage pressures are all given with an 0.3 after them and the gage pressure corresponding with 90 absolute is 75.3. So I start in to tell him to add 14.7 to the gage pressure to get the absolute, and then it struck me that this is only right if the pressure of the atmosphere is 14.7 pounds, and if it happens to be so it is an accident. I can tell him to add the pressure of the atmosphere to his gage pressure, but how is he going to get the pressure of the atmosphere? If he takes it by the barometer, it will be right for that place and time, but may not be right for another place or another time or for the case that he is working on. And then he gets it in inches of mercury and he has to use it in pounds per square inch. No two authorities agree as to the weight of a cubic inch of mercury and it is dollars to doughnuts that he wouldn't have pure mercury in his barometer, and the weight per cubic inch varies with the temperature, which he would not know, and then again a cubic inch of pure mercury at the same temperature weighs less at the equator than it does at the poles on account of the centrifugal force, so that the latitude comes in. Gee, I could write a book about it. If I only knew half as much my work would be twice as easy."—*Power and the Engineer.*

CLIMATIC RANGE OF ATMOSPHERIC TEMPERATURE AND HUMIDITY*

By F. Z. Schellenberg.

The high temperature of 147 deg. F. for the air in the open, found on the sandy soil of Lake Erie, in the sun, is reported by botanists studying the habitat of Pennsylvania flora.

The record extremes of temperature in the shade at Pittsburg are 20 deg. F. below zero (Feb. 10, 1899) and 103 deg. above zero (July 10, 1881). Our average temperature through the year is 53 deg. The first frost is about Oct. 20, and the last April 20, just a month after the fall and spring equinoxes. It is remembered, however, that fifty years ago (1856 and 1859) killing frosts came in June, destroying the wheat crop within one month of its harvest time.

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*Journal of the Society of Engineers of Western Pennsylvania.

At zero Fahrenheit air is saturated with half a grain of moisture to the cubic foot, at 15 deg. with one grain, at 32 deg. with 2 grains, at 50 deg. with 4 grains, at 62 deg. with 6 grains, at 70 deg. with 8 grains, at 85 deg. with 12 grains, at 100 deg. with 20 grains, with a gradual reduction of density of the air amounting to one-fifth.

In the table following, from the Weather Bureau's observations at Pittsburg, for 31 years to end of 1903, the mean of the daily and then of the monthly is divided only for the four seasons, December 1 to November 30 as maxima and minima averages to reach the seasons' and the years' mean for the whole period: For the temperature in degrees Fahrenheit; precipitation in inches; and humidity of the air in percentages of full saturation and in grains absolute.

SEASON	TEMPERATURE IN DEG. FAHRENHEIT		PRECIPITATION INCHES		HUMIDITY RANGES	
	Mean	Maxima-Minima	Mean	Minima and Maxima	Saturation Per cent	Absolute wt. Grains Per cu. ft.
Winter.....	33	40-25	8.5	6.4-15.3	81-74	1.63-1.72
Spring	51	61-41	9.4	4.9-14.6	76-85	2.86-3.08
Summer...	73	83-63	11.4	7.4- 9 7	76-62	5.69-5.83
Fall.........	55	65-46	7.5	6.8-11.0	79-65	3.35-3.53
Annual.....	53	62-44	36.8	25.5-50.6	78-66	3.38-3 54

SEASONS' CHANGES IN TEMPERATURE AND HUMIDITY.

For temperature, the seasons' grand average minimum is 25 deg. and maximum 83 deg., and giving the seasons' mean equal weight would make the years' 54 deg., but the annual reach is finally between 44 deg. and 62 deg. for the series and gives 53 deg. as the average, nearly which (52.9) the annual is too from the years' averages summed by months' averages. The highest annual average (1000) is 54.7 deg., the lowest (1875) is 49.0 deg.

For precipitation we get the mean annual rainfall 36.8 inches through averages as in the table, but by years with the extremes 25.73 (1900) and 50.61 (1890) we have the mean annual total rainfall 36.38 inches.

Humidity ranges in the averages between 62 per cent. in summer and 81 per cent. in winter, with more absolute moisture (5.83 grains to the cu. ft.) in the former than in the latter (1.63 grains) and accords with the common belief that near three-fourths of one per cent., 50 grains of water in the pound of air, is the upper limit desirable for the free perspiration of the human body that tends to comfort under moderate exercise in fair weather.

The proper moisture in the air according to, and with mild, temperatures concerns keenly the workers in confined spaces, and should be parallel with ventilation, the prime object of which is the giving of pure air with its normal content of but .03 per cent. of carbon dioxide.

ANKYLOSTOMIASIS

This is a disease occurring among miners but not confined to them, being common among laborers in tropical countries, even field workers suffering from it. It is an intestinal disease due to the presence of a worm *ankylostoma dirodenale* in the upper intestine. The disease may be contracted in mines where in the damp and dirty conditions and the warm air the parasite multiplies rapidly when once introduced. The disease is acquired by miners while eating by swallowing larvae which get on their hands, and also by the worms passing through the skin, causing temporary eruptions. The symptions of the disease are quite similar to those of anemia.

A SIMPLE WOOD PRESERVING PROCESS

For several years the Forest Service of the U. S. Department of Agriculture has been experimenting with a method of impregnating wood, which requires no expensive equipment, is simple in operation, and is adapted to a plant of any desired capacity. It is now known that all of the more porous woods can be treated successfully by this method. The method is called the "open tank" or "hot and cold bath" process. The impregnation is accomplished by thoroughly heating the timber in a tank containing a liquid substance, then running off the hot liquid and filling the tank with cold, or transferring the timber from a tank containing hot to a tank containing cold liquid, or allowing the whole to cool without change.

The theory of the process is that the air in the wood cells and intercellular spaces expands when heated and is partially expelled. Upon cooling, it again contracts, thus causing a partial vacuum, and the pressure of the air on the outside forces the liquid into the wood. The process may be applied with any of the preservatives in common use; as for instance, creosote oil and zinc chlorid solution. The principle is the same whether the treating is done in a small tank holding a few fence posts and heated with a wood fire underneath, or in larger tanks fitted with steam coils for heating, pumps for handling the oil, and labor saving devices for handling the timber.

The result of the government's extensive experiments in wood preservation are published in circulars and bulletins, which may be had by all interested persons who address the Forester at Washington, D. C.

GERMAN COMPRESSED AIR MINE LOCOMOTIVES

We illustrate on these pages a type of compressed air locomotive introduced by the Berliner Maschinenbau-Actiengesellschaft, Figs. 1 and 2 being end and side outline elevations respectively, not to the same scale, and the half tone Fig. 3, showing a locomotive in actual service and stopped at a charging station for a fresh supply of air.

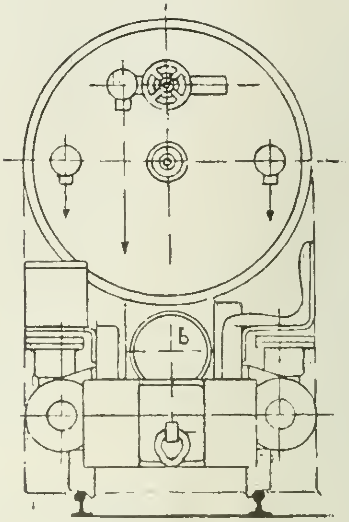


FIG. I.—END ELEVATION.

The standard pattern of the machine is of 8 to 12 nominal h. p., but is capable of working up to 24 h. p. as a maximum and, under ordinary conditions of gradient, will haul about 40 full tubs, each with a net load of 11 cwts., at a speed of 5 1-2 miles per hour. It will run a distance of about 1,600 to 3,200 yards with

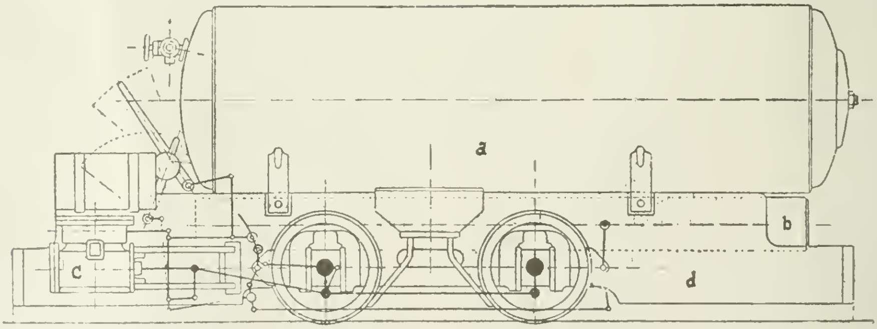


FIG. II.—SIDE ELEVATION.

a single charge of air, the pressure sinking from about 750 lbs. per square inch to 150 lbs. Even under the latter conditions, however, the engine can run empty for another 1,500 to 2,000 yards, so that the driver can easily reach a recharging station should the locomotive be unable to haul the train at any point of its course.

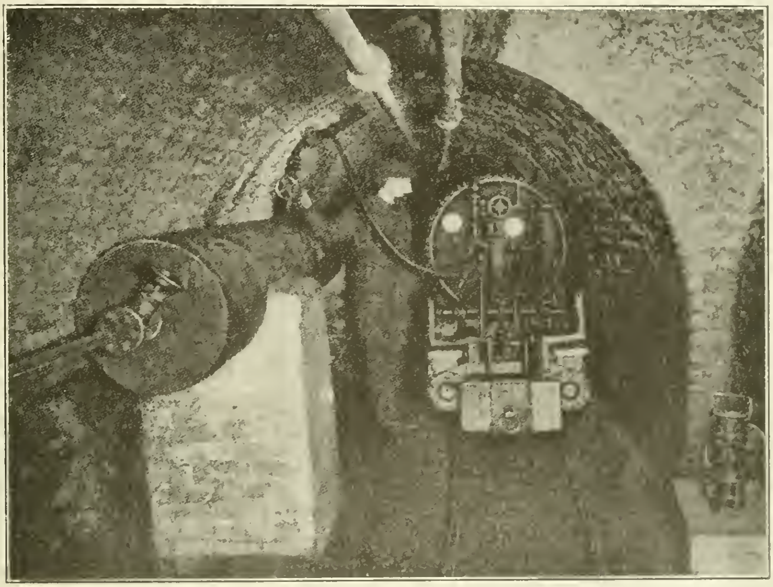


FIG. III.—LOCOMOTIVE AT CHARGING STATION.

The dimensions of the locomotive are as follows:—Total length over buffers, 13 ft.; maximum height above the rails, 5 ft.; maximum width, 3ft.; wheel base, 40 in. With these dimensions curves of 33 ft. radius can be negotiated without difficulty. The effective adhesion weight of the locomotive is about 5 1-2 tons, so that it is capable of exerting considerable tractive force, even on greasy rails, without slipping.

As shown in Figs. 1 and 2, the locomotive consists of the main air receiver, *a,* auxiliary receiver, *b,* the motion, *c,* and the frame, *d,* with the requisite valves and fittings, including safety valves and pressure gauges for both air vessels, a reducing valve, signal bell, sanding appliances, powerful brake, lamp, etc. The driver's seat is above the driving cylinders, and all parts of the motion are easy of access. The air supply is compressed to 1,125 or 1,500 lbs. per square inch, and stored in reservoirs. These are connected by air mains with charging reservoirs (Fig. 3), situated at convenient places for recharging. This latter operation is effected in a very short time; in fact, it is claimed that 1 to 1 1-2 minutes will be sufficient, on account of the high pressure in the recharging cylinders. The difference between the pressure of 750 lbs. in the locomotive air cylinder and 1,500 lbs. in the compressor equalises the work of the latter so that it can be kept running continuously even when the loads to be hauled are subjected to considerable fluctuation. In the event of the compressor supplying more air than is being consumed by the locomotives, an automatic valve on the former opens and allows the compressor to run empty until the pressure in the reservoirs has fallen below the limit of 1,500 lbs.

The working pressure in the engine cylinders is lowered to 150 lbs. by a reducing valve of special design, the air being passed through an auxiliary air chamber. An early cut-off enables the expansive power of the air to be fully utilized.

Railroads use in their locomotives one-quarter of all the coal mined in the United States, and fuel is the largest single item of expense in conducting transportation.

STEAM VS. COMPRESSED AIR IN MINING

The following we take from a paper by Mr. John Unsworth, before the National [British] Association of Colliery Managers:

As to the comparative values of steam and compressed air, it would appear on the face of the matter that it must be more advantageous to use steam direct, than to convert the steam power into compressed air power. It is, of course, patent that in the latter process you lose by friction, and in other ways, a considerable portion of the steam power, and this loss is variously stated to range from 25 to 50 per cent.; indeed, I have heard it stated that the loss may, and sometimes does, reach 60 per cent. My own experience, however, goes to prove that with the best type of air compressor, and using large pipes for conveying the compressed air from the compressor to the hauling engine, pump, or other machine which is driven by compressed air, the loss is always under 25 per cent.

There can be no question that compressed air is available as power *under all conditions,* while steam and electricity can only be applied under special conditions. Where you have furnace ventilation you may, if your steam boilers are in the mine, utilize the fuel used under your boilers as an adjunct to your furnace, and in this way effect a saving in your coal consumption for furnace purposes; but steam cannot be used except with a great deal of trouble and expense far away from the pit bottom.

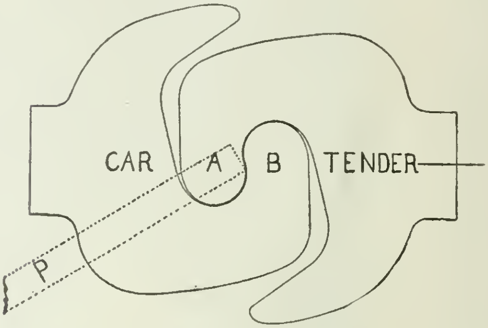
Taking everything into consideration, I am obliged to say that, in my own experience, I have found compressed air much more convenient, as a motive power, than steam, and on the whole not much, if any, more expensive. Mechanical power for other purposes in the mine has progressed during the last half-century, from *nil* to a very large quantity. Pumping, coal-cutting, and belt conveyors for carrying coal from the face of the mine to the haulage or other main road, are all done now by power of one or other of the classes referred to.

It is said that in the stripping of the heavy over-burden in its ore properties on the Mesaba Range the United States Steel Corporation is handling about as much earth as is being shifted at the Panama Canal.

VACUUM A PUSH AND NOT A PULL

The following, from the Locomotive Firemen and Enginemen's Magazine, should settle it for all time about the action of a vacuum:

In the air brake car, the other day, the instructor had just finished explaining the action of the air pump to several young firemen who were somewhat slow in understanding the business that transpires in the air end. Realizing that he had a good-sized audience of enginemen that had drifted in, and who seemed interested in his demonstration, the instructor observed: "Gentlemen, there is no such thing as *suction,* nor *pulling;* those words are proper to use in their common application, but they refer to movements of matter that are inspired in exactly an opposite manner to that suggested by the terms as used."

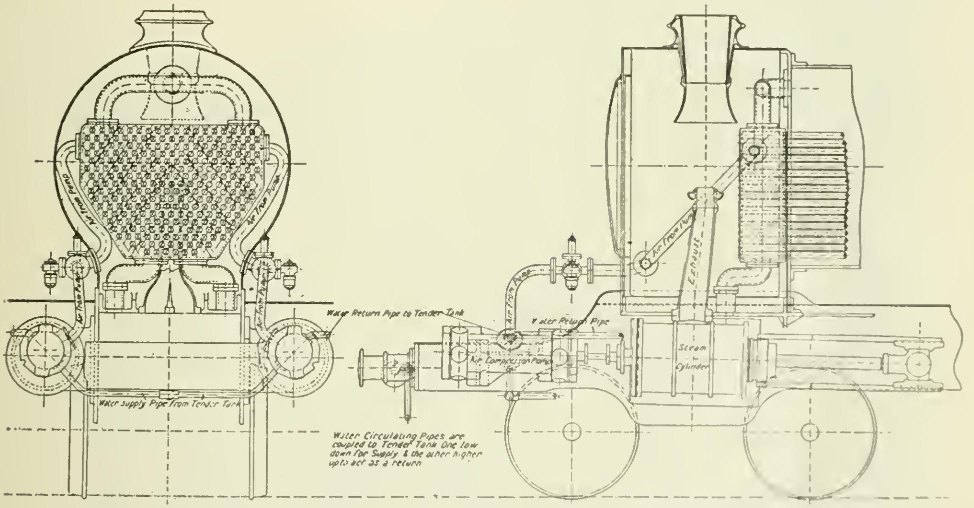


A PULL IS A PUSH.

"Huh!" remarked Hank Ely, "the last quarterly dividend on Air Line Stock was made possible by the freight tonnage that the 259 persuaded up an' over the hills o' this yere pike, an' she's always connected onto the head end of the train. I sort o' 'lowed she was doin' some tall pullin', especially up Summit, but I see I was mistaken. An' when a drawbar is extracted from the end of a car *I push it out!* Yes, I see. An' *they ain't no suction!* When the reverse lever's in the one-an'-only notch, ask Daly what snatches the coal off'n his shovel 'fore he gets it through the firebox door; I used to think it was the suction resultin' from the blast of the exhaust steam in the front end—but that was foolish of me."

Hank's an amusing soul, and the instructor laughed with the rest; then he said: "Well, I could show you that at every point of the application of force in the motion work of the engine the effect is *a push;* but we'll take up the question of the engine pulling the cars—as you have termed it. Here is a sketch of the couplers on the hind end of the tender and front end of the first car of the train;" and he chalked up a rough drawing of a pair of coupled drawbars, like this:

"With the locomotive moving forward," the instructor explained, "the tender coupler shown in the sketch is carried to the right and in engagement with the car coupler the car is impelled to the right. The coupler knuckles, *A* and *B*, sustain the resistances between force and inertia, and their inner faces at the points of contact is where the energy supplied to knuckle *A* of the tender coupler from the motive power of the locomotive is transmitted to knuckle *B* of the car coupler; and I will leave it to any one present:—doesn't knuckle *A* *push* against knuckle *B*?


Air from Pump
Air from Pump
Air from Pump
Air from Pump
Water Return Pipe to Tender Tank
Water Supply Pipe from Tender Tank
Air Compression Pump
Water Circulating Pipes are coupled to Tender Tank One low down for Supply & the other higher up to act as a return
Air from Pump
Air from Pump
Exhaust
Water Return Pipe
Steam Cylinder

LOCOMOTIVE USING SUPERHEATED STEAM AND COMPRESSED AIR.

SUPERHEATED STEAM AND COMPRESSED AIR

The combined use of air and steam in fluid pressure engines is by no means a new idea; proposals to carry it out in various ways have been made at intervals for the past fifty years or more, and there have been a few experiments in this connection in years gone by; but so far as we are aware the only apparatus of this class which has proceeded beyond the purely experimental stage, and of which there are several in actual work, is that devised by Messrs. Field and Morris and introduced by the New Century Engine Company, Limited.

The thermodynamic virtues of compressed air and the general characteristics of steam are, of course, well known; but the condition of affairs when the two fluids are mixed and superheated together is not so clear, and it is necessary to deal more with the facts as they occur in actual practice than with theory on its own merits. According to this system an air compressor is employed, this being usually run by the engine to be operated, and the air is supplied, preferably at a pressure substantially the same as that of the steam, to a superheater to which the steam is also supplied, the two fluids intermixing and being together superheated, after which the combined fluid, or "aërated steam," as it is sometimes termed, is used in the engine cylinders.

The compression of the air, of course, entails the expenditure of energy, and this is necessarily debited against the actual output of the engine itself; but in consequence partly of the fact that some of this energy is converted into heat, and partly for reasons which can only be guessed at or theorised upon, it has been found in practice, we understand, that the work lost in compressing the air is more than made up for by the increased efficiency of the mixture of superheated air and steam. As an attempt to explain what occurs, it has been suggested that the air tends to form an envelope to the steam particles which resist the tendency to condensation which would otherwise occur, as temperature and pressure fall during expansion. It appears to be more probable, however, that, owing to the fact that the compressed air itself contains great heat, and its temperature may be higher than the temperature of the saturated steam at high pressures, such as 180 lb. or 200 lb. per square inch, the mere admixture of the air with the steam exercises to some degree a superheating action upon the latter, so that the superheating of the mixture with an apparatus that for steam alone will give only a moderate degree of superheat is enabled to give a higher degree of superheat.

The system has been applied in several ways with, we are informed, substantial economy—indeed, a saving of as much as 15 per cent. to 20 per cent. is claimed, and it is stated that even greater economies have been obtained.

For the present, however, it is the application of the system to locomotive engines that is in question. For several years a number of small engines have been fitted some of them having been used for exhaustive trials on a testing plant, while one or two larger engines have been used in regular service on main railways for trial in every-day work. About two years ago, by arrangement with the North British Railway, a standard goods engine and, more recently, one of the large "Atlantic" type express engines of that line, have been fitted with the apparatus, the former having been used extensively in every-day work, while the latter was exhaustively tested. The cut on the preceding page shows the general arrangement of the apparatus.

The air compressing cylinders are arranged tandem to the steam cylinders, and the pump pistons are operated by tailrods, the design being such that the air is supplied substantially at 200 lb. per square inch (the steam pressure). From the air pumps the air passes to the box superheater in the smoke-box, to which the saturated steam from the boiler also passes, and is there admixed with the steam. Here the mixture is superheated, afterwards passing to the working cylinders. The superheater is of simple type, comprising mainly a chamber having smoke tubes in line with, and abutting against the ends of the boiler tubes, and with diagonal partitions as shown whereby the mixture of steam and air is forced to follow a zig zag path from the upper side portions of the superheater to the lower central portions thereof. The air pump cylinders are water-jacketed, the circulating system being connected with the water tanks in the tender.—*The Engineer*, London.

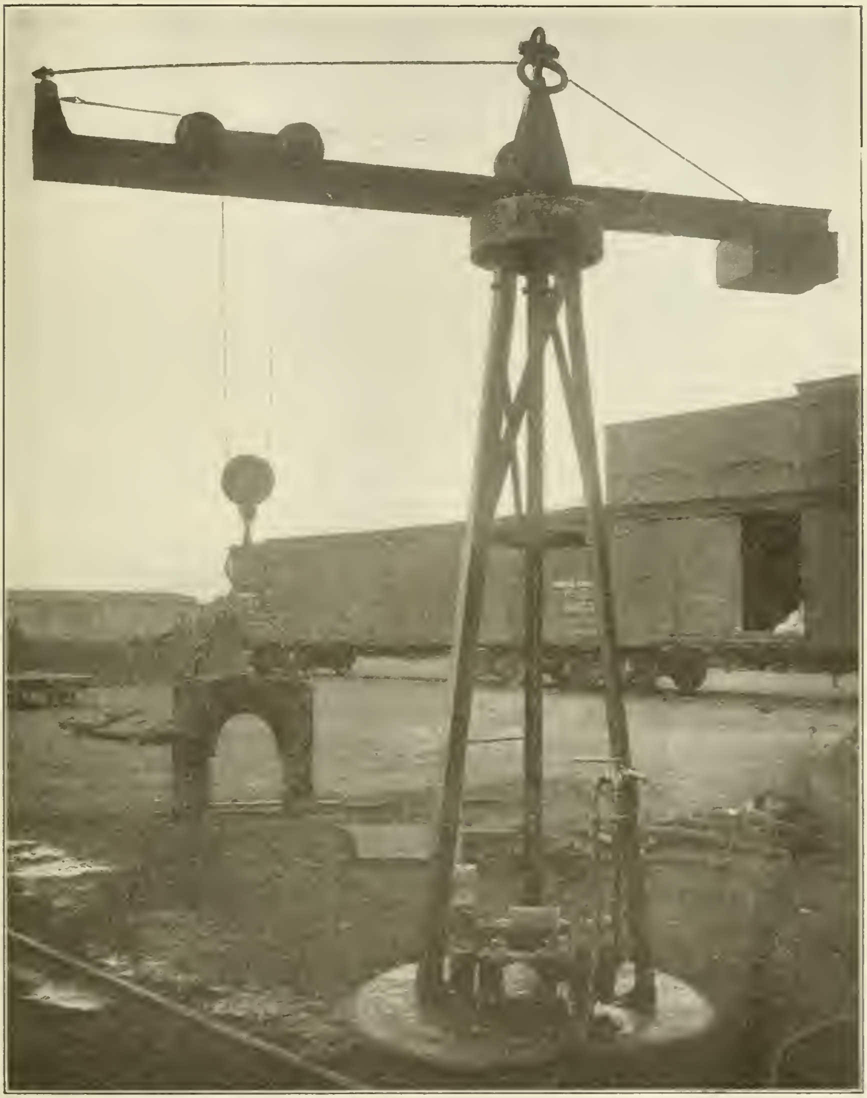
POWER VALUE OF AIR AND GAS

The suitability of a gas and air mixture for supply of a gas-engine or a blast furnace depends on its thermal value, pressure, temperature, and moisture. These quantities are continually varying, and a simple method of testing the quality of the mixture is desirable. Herr W. Heim points out that when the proportions of gas and air can be varied at will it is only necessary to withdraw a small constant volume of the mixture and to ignite it, and to determine by repeated experiment which proportions give the highest flame temperature, as the mixture with this proportion will be the most efficient. The temperature indication can be conveniently carried out by means of an electric pyrometer and galvanometer. By connecting such an apparatus to a small chamber in connection with the gas-engine cylinder, the adjustment of the proportions of gas and air to meet the varying conditions may be made with precision.

A PORTABLE AIR OPERATED JIB CRANE

The half-tone shows a portable jib crane the invention of H. H. Maxfield and G. C. Gardner, Jr., Mr. Maxfield being Master Mechanic of the shops of the Pa. R. R. at Trenton, N. J., and the crane being shown in actual use in the railroad yard at that point. The crane has been in service for two years and has completely demonstrated its efficiency, reliability and general usefulness.

The half-tone shows the entire device so completely that little needs to be said in the way of description. As here shown, the crane is used for light local work in connection with a large dominating traveling crane, the latter picking it up by the loop at the top, depositing it wherever required, and moving it at a moment's notice from place to place. The round, flat base here shown may of course be replaced in construction by a rectangular or other form, and may be provided with wheels to run on a track or elsewhere.



PORTABLE AIR OPERATED JIB CRANE

The crane as here shown was designed to lift 1,000 lbs. at the end of the jib without any support or bracing, and, as a matter of fact, has so lifted 1,100 lbs. The carriage, with or without a load, is easily movable in and out upon the beam, and the entire upper part rotates without friction, being carried upon conical friction rollers having horizontal axes, a similar set under the flange also preventing the head from rising or tipping, and vertical rollers also keeping the parts always concentric. The power is furnished by an Ingersoll Rand rotary air motor geared with a single reduction to the hoisting drum, which is so located that when the wire rope is in the middle of the drum length it is exactly vertical and central, corresponding precisely with the location of the sheave overhead. The hoisting and lowering is controlled entirely by the single valve and there are no levers or other devices to handle or look after.

BLOWN-OUT SHOTS IN COAL MINES

For years the public has been hearing of mine accidents being caused by "blown-out shots" igniting coal dust and gas, and since it figures again, in the verdict of the coroner's jury, as the cause of the recent disaster at Marianna, interest in the subject has been stimulated to a high point. What is a "blown-out shot" and how does it operate to do damage?

At the government mine explosive testing station at Arsenal park, Pittsburg, demonstrations in answer to this question are given almost daily. One of the big steel chambers or tubes is filled with a mixture of coal dust and gas, and then flames are shot into it from a cannon; that is, there is an explosion of powder or fulminate in the cannon, which operates the same as a "blown-out shot" in communicating flames to the dust and gas charged chamber. In a mine the shot, instead of being blown out of a cannon, is blown from a six-foot chamber, an inch and a half in diameter, that has been bored into the solid block of coal. This, of course, occurs only when the things do not work properly. It will be seen, however, with what force a charge of powder will shoot from such a hole; just the same as if it were coming from a rifle.

This will be still better understood by the layman when the method of blasting down coal is explained, using the Marianna mine as an illustration. This mine, being new, consists only of entries, nine feet wide. The vein averages six feet in thickness. In taking out the coal the miners "under-cut" a section of the solid block with a machine, which takes out about six inches of coal from under the block and as a rule this under-cutting is entered into the solid body about six feet. This is to enable the forcing down of the coal by a blast, if it were not for the under-cutting, of course, the explosion not only would be more dangerous to the men, but less effective in taking out the coal. Something has to give way when the force of dynamite is released within the enclosure. The undercutting provides for this and, in case of the entries of the Marianna mines, enables the blasting down of the coal in blocks about nine feet long and six feet square.

After the undercutting is completed the miner, with an augur, bores into the block of coal at the top a hole an inch and a half in diameter and six feet deep. The fulminate tube or cartridge, which is about 10 inches long and an inch in diameter, is pushed into this hole, clear to the end. The layman might imagine that the hole would be drilled into the coal at about the middle of the block. Instead it is located at one of the sides.

Its force jars down the entire block that has been undermined. After the cartridge has been placed in the hole a small iron rod is inserted and the tamping in of clay commenced. When the tamping process is completed the iron rod is withdrawn and this leaves a hole through which a squib-like fuse is sent in to put off the fulminate cartridge. The miner has plenty of time, after starting in the fuse, to retreat a safe distance before the explosion occurs. "The blown-out" shot is where the explosive blows out the tamping instead of the coal.—*Connellsville Courier.*

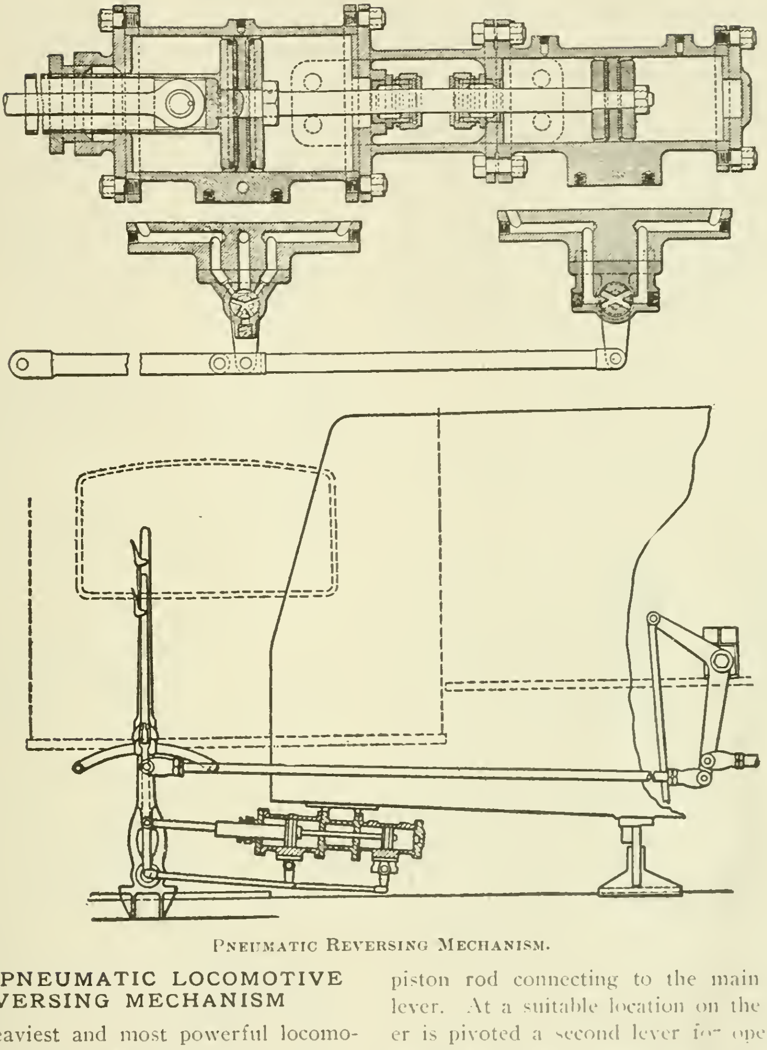
THE SAVING BY THE GAYLEY PROCESS

The original plant was installed by the Carnegie Co., at the Isabella furnace, Aetna, Pa. The moisture in the air is a factor which affects the character and quantity of iron produced, and, as most operators of air compressors are aware, is equally important in realizing the efficiency of utilization of air in this development.

The plant installed was of 450 tons refrigerating capacity; that is, there were two machines capable of producing refrigeration equivalent to the melting of 450 tons of ice in 24 hours. The moisture content removed from the blast was 40 gal. per minute for each grain of water vapor per cubic foot of air content, and the water vapor often rose as high as 8 grains per cubic foot and possessed an average of considerably over 5 grains.

Over 10 tons of water were removed per day, and the speed of the blowers was reduced, with a reduction in horsepower of from 2,700 to 2,013, a saving that more than operated the refrigerating machines, for at their maximum capacity they required only about 530 hp., and generally about one-third of this.

The air consumption was cut from 40,000 cu. ft. per minute to 34,000 cu. ft., and the iron production was increased from 350 tons to 450 tons per day, with a diminution in coke consumption of 2,100 lb. to 1,730 lb. per ton of iron.



Pneumatic Reversing Mechanism.

HYDRO-PNEUMATIC LOCOMOTIVE REVERSING MECHANISM

In the heaviest and most powerful locomotive in the world, a Mallet articulated compound, built for freight service on the Erie R. R., by the American Locomotive Company at Schenectady, N. Y., and described in a recent paper before the American Society of Mechanical Engineers, one of the interesting features is the hydro-pneumatic reversing mechanism a sketch of which appears in the cut. In the upper portion of the cut the operating cylinders and valves are shown in section, and below that is an outline sketch of the entire apparatus.

There are an air cylinder and an oil cylinder of smaller diameter in line, the common piston rod connecting to the main reversing lever. At a suitable location on the main lever is pivoted a second lever for operating the gear. A forward movement of this lever throws its lower end backward, turning the valves of both cylinders, thus making communication with the rear end of the air or operating cylinder for the air pressure to force the piston forward, and with it the entire gear. The oil cylinder, serving as a lock and regulator, has by this movement established intercommunication between both sides of its piston, allowing the latter to follow the movement of the gear, but securing for it a moderate and uniform motion because of the contracted passage for the oil through the valve. By stopping the movement of the operating lever the gear moves the main lever up to the given relation to the former, and then automatically shuts off the air supply and locks the oil cylinder piston.

In unlatching the operating lever the same movement raises the main latch, which cannot drop until again in the given relation to the former, when the valves of both the air and the oil cylinders are closed and a positive locking of the gear is secured, in addition to that of the oil lock. The handle part of the main lever is necessary for the purpose of operating the engine by hand in the absence of air pressure or in case of derangement of the gear.

BETTER LIGHT AND AIR FOR MINES

By A. Cressy Morrison, Chicago.

For several years acetylene has been used in miners' lamps in France, Germany and Belgium to a large and steadily increasing extent, until at present it is used almost exclusively in over 200 mines and by approximately 50,000 men. The light is satisfactory and saves nearly 50 per cent. of the cost, giving more and better light. Mining engineers have been more or less familiar with this fact, but the introduction of acetylene into mines up to the last two years has been very slow in this country. Its use is now, however, coming to be recognized as an important advance, and it promises shortly to replace all other means of mine illumination, except in special cases. It is seldom that an improvement in quality or advantage is accompanied by reduction in cost, but the paradox is a reality in the case of acetylene.

Candles, which are largely used throughout our Western mines, remove seven times and kerosene five times as much oxygen as acetylene. The products of combustion given off by candles are 10 times and from kerosene 9 times as much as that given off by acetylene. The difference is therefore enormous. The actual amount of illumination given by candles and kerosene is lessened by a very large percentage by the smoke and mist which so rapidly accumulate, whereas all the light given by acetylene reaches the point to be illuminated without any interference whatever.

It has been found in actual experience that in entries which are 60 to 70 ft. ahead of the air, there is not the slightest particle of smoke from an acetylene lamp and the entry is just as clear at the end of a shift as it is at the beginning.

An interesting thing about acetylene is the tenacity of the flame. It is not easily blown out, the rapid motion of the miner will not cause it to flicker badly, and it burns brilliantly in an atmosphere so foul that candles fade and go out. In fact, acetylene will not deprive the miner of light until the atmosphere is so bad it will not support life.

For underground surveying and mine inspection, the use of acetylene is of great importance. Maps and records escape the usual accompaniment of grease and smudge. The acetylene flame is so small and clear that it affords an accurate point on which to sight instruments.

Another use for acetylene in somewhat larger units is found where the rays are concentrated by a reflector, in which case a brilliant illumination can be thrown into inaccessible places where distant bays, high backs, caved places and other difficult and otherwise hidden parts of the mine can be explored with convenience and in case of emergency without danger.

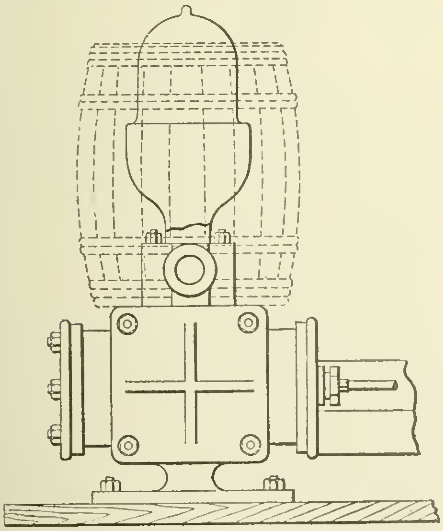
In actual practice it has been found that 4 oz. of calcium carbide at 4 cents per pound will give nearly 10-candle power clear illumination without smoke for 5 hr. One-half pound, or 2 cents' worth, will give the same illumination for 10 hr. Candles in many parts of the country, counting four candles to the 10-hr. day, would cost 5 cents per day.

Acetylene miners' lamps are now frequently found in mines throughout the country, Pennsylvania, New Jersey and Illinois leading, though many other States are using the new light. The greatest number used by any one concern in its mines is probably by the New Jersey Zinc Company of New York, which has adopted acetylene illumination for all its mines. The number of miners' lamps in use in the mines of this company is about 3,000, and it has been found in practical use that the saving is at least 2 cents per day for every miner. The whole method of using acetylene is so simple and the lamps now in practical use are so satisfactory that the subject of better illumination in mines is worthy of the attention of every mine owner and engineer.

CYANAMID, OR LIME-NITROGEN

Calcium Cyanamid, generally spoken of commercially as simply cyanamid, is one of the most important fertilizers which science has brought within easy reach of the agriculturist. It is a granular, minutely crystalline substance, free from fine dust, and stores indefinitely in bags or bulk. It is said to mix with all other fertilizers in any proportion with no coalition of heat, no liberation of ammonia, no reversion of water soluble phosphoric acid, no reversion of citric phosphoric acid, and no change in weight.

Coke and lime are used in the manufacture, with the aid of an electric furnace, the resulting compound being in turn pulverized and combined in a second electric furnace with nitrogen obtained by the evaporation of liquid air. The final compound is calcium cyanamid or lime nitrogen, a nitrogenous material whose ammonia is direct from the atmosphere.

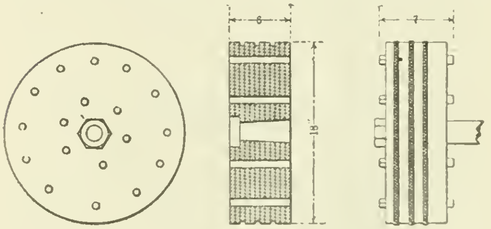


CONCRETE AND A BROKEN AIR CHAMBER

The cut herewith, reproduced from the American Machinist, tells the whole story of how concrete helped a contractor to keep his work going. Away back in the country a water power plant was being built to electrify a town down the valley. A steam pump was keeping the water out of the excavation and an unlucky swing of the derrick boom caused a loaded bucket to hit the air chamber of the pump and broke it off as shown. It was miles to a repair shop and a delay of several days seemed inevitable, but a way out of the trouble was quickly found. The air chamber was put back in position, an empty barrel, minus both heads, was placed over it, with a notch cut out of one side to clear the discharge pipe, holes and openings were plugged and then the barrel was filled with concrete. After waiting over night and the next day for the mass to harden, the pump was started and it ran all right until the work was finished.

A BREAKDOWN AND A TEMPORARY STEAM PISTON

The sketch herewith, adapted from *Power and the Engineer*, shows an emergency piston used in the steam cylinder of a disabled air compressor. The original piston was wrecked when the heads of two follower bolts broke off and fell into the clearance space. The spider was split and the follower plate was broken. The air from this compressor is in constant demand, so a temporary piston was constructed as follows:



We sheared out 12 plates of 1/3-inch tank steel in circles 18 1/8 inches in diameter and bolted them together, as shown, by eighteen ¾-inch bolts. These were drawn up as tightly as possible and the piston put in a lathe. The taper hole in the hub was bored out to fit the piston rod and the piston turned down to the proper size. Three grooves were turned in the surface, 5/8 inch wide and 9/16 inch deep, and high-pressure spiral packing was forced into the grooves. The bolt heads and nuts projecting through the outside plates were turned off so as to make the piston 7 inches thick, the dimension of the broken piston.

The piston was then put on the rod, fitted into the cylinder and run for four or five days, when the new piston was put in. The temporary piston, when taken out, was in good shape, excepting the packing, which was pretty well used up.

The steam pressure was 160 pounds, with 100 degrees Fahrenheit superheat. The piston was rather heavy, but it did the work and no damage was done to the cylinder; in fact, the surface was finely polished when taken out.

CONSTITUTENTS OF THE UPPER AIR

Teisserenc de Bort has been making a study, as interesting in its methods as in its results, of the constitution of the upper atmosphere, and especially of its richness in helium, argon, and the other gases. His investigations were confined to the permanent isothermal stratum which extends from the height of 26,000 feet to that of 46,000 feet above sea level, and the origin of which is yet unexplained. If the upper atmosphere differs essentially in composition from the air near the ground, the specific differences ought to show most clearly in this elevated isothermal stratum, which is not contaminated by the ascending and descending currents caused by cyclones and barometric depressions. The specimens of air were collected by a very ingenious method. A glass tube, which had been exhausted of air and sealed by fusing its pointed ends, was attached to a sounding balloon in such a manner as to avoid the possibility of absorbing hydrogen leaking from the gas bag. When the balloon attained a certain altitude the closing of an electric circuit by the barometer or by the clockwork of the meteorograph caused a little hammer to fall and break one end of the tube. Air entered and filled the tube, which was then sealed by the automatic action of an accumulator, the current of which heated to redness a platinum wire coiled round the broken end of the tube and fused the glass by the heat thus produced. The quantity of air that can be collected in this way is too small for quantitative chemical analysis and can only be analyzed qualitatively with the spectroscope. Two methods have been employed. In one, all the constituents of the air, except helium and neon, are absorbed by charcoal. In the other method, the argon is separated first. Argon and neon were detected in all, specimens collected at elevations between 26,000 and 46,000 feet. The yellow line of helium appeared in the spectra of all the specimens except one which was collected at the greatest height attained, about 46,000 feet. The presence of krypton could not be determined with certainty.—*Scientific American.*

THE ELECTRIC AIR DRILL AT HIGH ALTITUDE

The following, translated and abstracted from *El Comercio,* Lima, Peru, tells of the successful operation of two Electric Air Drills at the Germania mine of Lizandro A. Proano, in the Huarochiri district:

Owing to the hardness of the rock at the Germania mine—it can be considered the hardest in Peru, making the use of wood unnecessary—the progress made in the veins of the mineral was slow, and the miners claimed that the rock was too hard to be drilled satisfactorily by machinery. Besides, the altitude—which is almost 16,000 feet above the sea level—the bad roads, and the distance from the railroad were great obstacles to the use of machinery of any class.

The circumstances induced Mr. Proano to look into the employment of a drill which would work on an entirely new principle and which promised to solve the difficulty; this was the Electric Air drill. The complete installation as adopted comprised a 45 kw. General Electric generator driven by a direct connected Pelton water wheel, and two 5 h. p. Electric Air drills, these being the largest manufactured.

The plant was put in running condition a few days after its arrival, Mr. Dick of the house of W. R. Grace & Co. taking charge of this work and also that of instructing the operators. They grasped the management of the machines so rapidly that in a short time the drilling of the principal tunnel was under way, working with but one drill and advancing at the rate of a meter per day, thus doing away with the idea of the miners that the rock was too hard for the use of machines. As the progress which had been made by active hand work was only at the rate of 3 meters per month the advantage gained by the use of the drills was sufficiently evident.

The principle upon which these drills work is very simple. A small electric motor is mounted on wheels, so that it can be moved along the tunnel on the car tracks, and directly connected to the motor is a pulsator which does the work, but in a different way, of the compressor formerly employed. The pulsator does not compress air continuously, but the two cylinders each compress a cylinderful of air alternately, these cylinders connecting by separate hose to the two ends of the drill cylinder. One cylinder drives the drill piston forwards and the other backwards, the same air being used over and over.

The advantage of this system can easily be seen. The air at an altitude such as that where this mine is located is very thin and has only a pressure of 8 lbs., while at sea leved the pressure is 14.7 lbs., so that if a compressor of the ordinary type was employed it would require to be very large and would consume much power. The Electric Air drill uses only one-third the power that an ordinary air drill uses. Large air pipes are not required in the mine, but only the wire, which can be used also for lighting and other purposes. These drills promise positive advantages to the national mining interests of Peru, because of the saving of labor—which is scarce in Peru—and above all of the cost of operating.

SOME TYPICAL WASTES

The following occurs in a paper by I. C. White, State Geologist of West Virginia, read before the American Mining Congress, Pittsburgh, Dec., 1908.

It can do no harm to recall some of the sins of waste committed by your people in the past, since many of these still persist. The citizens of Pennsylvania, and especially of the Pittsburgh district, have already wasted more of their precious fuel supplies, both solid and gaseous, than they have ever used. More than thirty thousand beehive ovens continue to consume almost within sight of your great factories, one-third of the power, and all of the precious by-products locked up in the finest bed of coal the world has ever known, and of which, as we have seen, you have such a limited supply. The quantity of natural gas, the best of all the fuels, which Western Pennsylvania has wasted from the many thousands of wells drilled within her borders, vastly exceeds in value all of the petroleum she has ever produced. Not satisfied with thus despoiling your own fair commonwealth of its most precious fuel possession, some of your most powerful corporations, with headquarters in Pittsburgh, have been the principal agents in wasting unnumbered billions of cubic feet of this precious fuel in your sister states of Ohio and West Virginia. The general superintendent of one of your great gas companies told me only a few days ago that he had personal knowledge of one well in West Virginia from which twelve million feet of gas escaped daily in producing only four barrels of oil, and this spectacle of wasting the heating value of 12,000 bushels of coal daily, together with the *power to deliver itself free of charges for transportation* to Pittsburgh's factories, was at that time not an isolated case, but only one of hundreds. During this riot of waste, one of your great gas companies put into its lines in West Virginia nearly one hundred million cubic feet of gas daily and delivered in Pittsburgh *much less than half that quantity*, the larger portion having escaped into the air through the defective joints of cheap and imperfect pipe line construction.

A PHILLIPPINE SUBSTITUTE FOR LIGNUM-VITAE

A substitute for lignum-vitae is said to have been discovered in the Phillippines. In 1906 such demands had been made on the West Indian forests for this wood that it was suddenly discovered that the supply of the Lignum-vitae tree had been almost exhausted. Consternation seized the manufacturers who were constantly making use of the product and they began writing to other parts of the world to learn whether there were other available forests of this valuable tree and, if not, what was the nearest substitute that could be obtained.

Major Ahern of the Phillippine Bureau of Forestry states that a wood answering the requirements has been found. This wood is called Mancono. Its technical name is Xanthostemon verdugonianus, Naves

The Mancono tree grows in considerable abundance in northeastern Mindanao. Small areas contained almost pure stands of it The wood is so heavy and hard that it is difficult to cut, and the splitting of a log of it is almost impossible.

However, it grows in places easily accessible to those wishing to work it, being usually found along steep slopes near beaches whence it can be shipped by water transportation Also, as it is only desired in short lengths, work on it can all be done in the forests where it is cut and the material can be easily handled.

The wood of the Mancono tree, even in the tropics where rot and decay are so ready to seize on all perishable materials, is practically indestructible. White ants, the curse of the tropics, do not attack it. This quality has already made the wood esteemed by many of the Filipinos in the southern islands who use the cumbersome logs for posts and ground timbers.

The heartwood of the tree is uniformly reddish black, but after a number of years of seasoning it turns a black walnut color. Like all Philippine hard woods, it takes a fine polish.

A LESSON IN PIPE CORROSION

Mr. Edward K. Judd, Instructor in Mining, Columbia University, tells, in The Engineering and Mining Journal, of a costly experience with a compressed air pipe line. At a certain group of bituminous mines, he says, a very complete and expensive air-compressing plant was erected in a central position, and the compressed air was to be carried to the mine openings through lines of 10-in. wrought-iron pipes. One of these lines, nearly one mile long was laid for part of its distance in a trench dug along the side of the railroad yard. This yard had previously been graded and ballasted with washery waste, consisting principally of slate, but carrying a large percentage of sulphur.

When the compressors were started, about six months later, it was found, on investigation, that the portion of the pipe line through the yards had in the meantime been so completely corroded, in spots, as to be totally useless. The destruction of the pipes is obviously explained by the oxidation of the iron sulphide in the washery waste, with its accompanying liberation of sulphuric acid. Corrosion occurred in spite of the fact that the pipe was carefully bedded in clay.

In replacing this pipe line, the company has wisely laid the pipe, carefully painted with asphalt over the surface, supporting it at intervals on wooden blocks and stones. As a one-mile length of wrought-iron pipe represents an outlay of about $5000, the saving to be effected in this way is quite apparent.

IRON DUST AND FAST COLORS

A Scotch manufacturer with an established reputation for making black goods guaranteed always fast color, proudly invited a chemist friend to see his mill. Reaching the weaving room the looms were making such a terrific racket that they could not talk. When outside the chemist asked, "What's the matter with your looms, they make a fearful noise?" The weaver whispers, "That's the secret, but I don't mind telling you I have found out by experience and experiment that the noisier my looms, the faster are my colors." "Give me a piece of the undyed cloth," asked the chemist. Examination showed him that the wear and abrasion of the metal parts of the looms had liberally sprinkled the cloth surface with iron dust, which went with the cloth to the dye tubs, and here was the secret of the fast color. The chemist, for a consideration, of course, gave the manufacturer a solution to mix with his dye and thus fix his color,—certainty of results without noise. Scientific method versus untutored experience slightly tinged with superstition.

HOW GAS ENGINES WORK

The following has been devised in the way of an explanation for the non-technical reader of the power developing operation of the gas engine:

Let us set a spiral spring on a platform. If we press down this spring and release it, it will, disregarding friction and heat losses, push up as much weight as was required to push it down. Suppose now that, when compressed, we could suddenly stiffen the spring. It would then lift more in opening out than was required to compress it, and the difference will be a gain in useful work. In a gas-engine we draw in a piston-full of air with some gas. The piston compresses this mixture, just as we compress the spring, and when it is thus compressed an electric spark fires the mixture, and its sudden burning greatly increases the pressure, or stiffens the spring, and drives the piston back with greater force than was required to compress the cooler mixture.

A company has been formed for boring another long tunnel under the Alps. It will be 28 miles long and it is estimated that the work can be done in three years.

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FOR THE AFTERCOOLER

Explosions more or less disastrous, though not generally attended with loss of life, are more frequent than they should be in compressed air practice. Undoubtedly most of such accidents are avoidable, but the knowledge of the conditions essential to safety has been disseminated more slowly than the air compressors have been distributed, so that the frequency of compressed air explosions has increased rather than diminished, and naturally the explosions occur most frequently in connection with the lines of compressors most numerously represented.

The explosions which occur are as a rule not due to the pressures carried and the weakness of the enclosing metal, and they are in fact as frequent with air of comparatively low pressure as with the higher pressures. We have noted quite recently an accident of a typical explosion where the air pressure was only 17 pounds. It is generally conceded that the explosions spoken of are caused by the formation of an explosive mixture of compressed air with a volatilized and inflammable constituent of the oil used for lubrication. For the formation of the explosive compound in this way heat is necessary, and for its ignition with disastrous results more heat, so that high temperatures rather than high pressures are what to avoid or prevent. There is at this point nothing more suggestive of safety than the aftercooler.

In connection with continuous compressed air service, as in operating an extensive mine, or in driving a long railroad tunnel, more attention should be given to the cooling of the air as it leaves the compressor. Aftercoolers have not been generally adopted, or, indeed, even advocated or recommended, being too often thought of, if at all, as an unnecessary and unprofitable refinement of practice; and, yet, they are surely worth while. There are few cases where they would not be found to pay for themselves, contributing as they do in more than one way to economy and safety of operation.

Compression, after all, in all our compressor cylinders is nearly adiabatic. Water jackets are necessary to keep the metal surfaces approximately cool to avoid abrasion, but those surfaces have little effect in cooling the mass of air at any instant under compression, and some compressors deliver the air hot, some hotter, none cool.

If an efficient intercooler is placed as near as possible to the compressor cylinder, and if the air is by this means immediately cooled, its volume is reduced to the minimum and the air is then in the condition most favorable for the deposition of moisture. If the opportunity is then provided in a suitable and sufficient air receiver for the entrained moisture to precipitate no complaint from that cause should arise later in the ultimate use of the air for any purpose. The reduction of volume effected by the aftercooler would often make smaller diameters of piping permissible or reduce the friction loss and pressure drop, and the possibility of disastrous explosions would be practically eliminated.

AN EXPLOSION IN A COMPRESSED AIR MAIN

The following comprises the essential portion of a letter by Mr. J. A. Burgess to the *Mining and Scientific Press*, San Francisco, giving an account of the explosion of a compressed air main in the Mizpah mine of the Tonopah (Nevada) Mining Company, and embodying valuable suggestions as to the conditions under which such an explosion could occur and the best means of prevention. The italics are ours, marking one or two points which cannot be too much emphasized.

The plant in question consists of two 2-stage compressors, one a Fulton compressor, cylinders 25 and 15 by 18 in., running 120-125 strokes per min.; the other an Ingersoll compressor, type D2, cylinders 22¼ and 14¼ by 18 in., running 120-125 strokes per minute. Both compressors have unloaders of the throttled intake type, are water-jacketed about the cylinders, and have inter-coolers between the low and high compression cylinders. At the time of the explosion the compressors were connected with two 4 by 10-ft. receivers, one for each compressor, and the two receivers were connected to the main. Since the explosion a receiver, 6 by 16 ft., has been added to the system.

The explosion took place on the evening of a fair day, at 6:30 p. m., about 45 minutes after starting the compressors. It occurred in the 6-in. main, between 100 and 400 ft. from the receivers. The explosion was violent, and burst open most of the pipe between the 300-ft. level and the surface. The woodwork in the shaft to which the pipe was fastened did not show any scorching, thereby indicating that this portion of the pipe was not excessively hot at any time prior to the explosion. The usual working-pressure is 90-95 lb., but at this time it was only about 80 lb. The compressors were known to be working hot, but as no thermometers were in use it is not possible to state the temperature. In the attempt to improve conditions, the cylinder-oil being used was changed to one having a higher flash and ignition-point, but even with this oil, *combustion, but not explosion,* has occurred in the receiver attached to the Ingersoll compressor.

Among the unfavorable conditions under which the plant works are the following: An atmospheric temperature frequently in the neighborhood of 100° F. during the summer; an altitude of 6,000 ft.; and an Ingersoll compressor *designed for sea-level.* The Ingersoll compressor was installed first, later the Fulton was added, and various other minor additions were made from time to time as their need was felt; consequently the plant lacks the uniformity of design it would have had if it had all been installed at one time.

The cause of an explosion of this kind is obviously the presence in the system of an inflammable gas, or possibly dust, mixed with air in such quantity as to render it explosive. The presence of an inflammable gas may be accounted for in several ways:

1. It may be generated from an oil of low flash and ignition-point by a not unreasonably high temperature.

2. It may be generated from an oil of high flash and ignition-point by an excessive temperature.

3. It may be generated by high temperature from a tarry deposit of partly destroyed oil, carried over from the compressor. This is sometimes deposited in the pipes or receivers of compressors.

Among the ways of accounting for the presence of fine carbonaceous dust are:

1. Dust from outside sources, such as coal-dust from the blacksmith shop, drawn through the intake. This would probably be insufficient by itself to cause explosion.

2. Smoke generated by over-heating of oil or tarry deposits. This would doubtless be accompanied by gas, and may be considered as a part of the gas, as far as its effects go.

Ignition of the explosive mixture may have originated, in the Mizpah explosion, in the following places:

1. In the main where the explosion occurred. This seems improbable. The timbers

show no charring such as would be caused by hot pipes.

2. In the receiver. This seems possible.

3. In the pipe between the compressor and the receiver. This seems possible. It is here that a black sooty or tarry deposit is sometimes found.

4. In the cylinders or in the outlet pipe, due solely to a sudden increase of temperature caused by leaky or sticking valves, improper unloading devices, or by an outlet-pipe choked with carbonaceous deposit.

Wherever ignition occurred, it may have been caused by the catalytic action of a porous deposit of carbon, even though the general temperature were not high enough to ignite the gas under ordinary conditions. To quote from Ostwald's "Chemistry": "The oxidation of many substances by free oxygen is greatly accelerated when charcoal is present. . . . Gases which under given conditions act only slowly on, one another can be made to act more quickly with the help of charcoal."

If ignition occurred in the compressor, or in the outlet-pipe to the receiver, or in the receiver, we must account for the explosion occurring only in the main and not in the receivers. I would explain this by assuming that the receivers were filled with a mixture of gas and air in such proportions as to be inflammable but not explosive; that the mixture was explosive only in the main, and that combustion of the gas in the receivers was comparatively slow, in the nature of a flare, and served to transmit ignition to the mixture in the main. In a letter on this subject, Prof. Edmund O'Neill says: "The most favorable mixture is about one part of oil vapor to seven parts of air. As the proportion of oil vapor or air recedes from this proportion the violence of the explosion diminishes until there is no danger either way. The most violent explosion may occur with less air or with more air, according to the composition of the gas." From this it will be seen that we can have a gas-and-air mixture spread throughout the receivers and pipes, varying from a merely inflammable mixture in one place to a highly explosive mixture in another place. The heat of the flare would raise the pressure in the receiver and thus increase the pressure of the mixture in the main and render its explosion all the more violent.

The precautions deemed advisable are as follows:

1. First, where possible, a well designed plant, *built for the altitude in which it is to operate.* With a sea-level compressor working at a high altitude, *too great a proportion of the work is thrown on the high-compression cylinder.* Under this heading come the following details:

(a) Intake-pipe of wood and taking air from a place outdoors as cool and as far away from dust-producers, such as the blacksmith shop, as possible.

(b) Unloader to be of a design that will not cause excessive heating when the compressor is partly unloaded.

(c) Efficient intercoolers.

(d) *After-coolers between the high-compression cylinder and the receiver,* on a compressor that shows a tendency to overheat. This would tend to prevent the transmission of ignition into the receiver, even though gas were formed, and the gas would not ignite spontaneously in the receiver if cooled before getting there.

(e) Efficient water-coolers, where water must be used over again.

(f) Inlet to receivers to be at their top, and outlet about a foot above the bottom. This will insure the air entering the main being clean, and the coolest in the receiver.

(g) Blow-off cock at bottom of receiver.

(h) Check-valve between compressor and receiver. This may save the compressor in case of an explosion or flare in the receiver. [This suggestion, we take it, is little likely to be adopted.—Ed. C. A.]

(i) Recording thermometers and pressure-gauges.

2. Use the best oil obtainable for the purpose, and *as little of it as is consistent with proper lubrication.* It would seem that a good oil, with as high a flash and ignition-point as can be produced with the necessary fluidity, would be the most desirable; for a poor oil would doubtless furnish the condition for explosion at a lower temperature than a good oil.

3. Use well regulated oil-cups with sight feed. If oil is fed in excess of the requirements of the pistons, it will accumulate in the cylinders, when they are unloaded, as there is no opportunity for it to be blown off with the air. In machines where overheating is apt to occur, this gives a favorable condition for gas production

4. Clean the outlet valves once a week

A PIPE EXPLOSION AND A RUNAWAY COMPRESSOR

A writer in a recent issue of *Power and the Engineer* tells of a compressed air accident in a railroad shop which wrecked things in general. The accident was a progressive one, the first trouble being the explosion of about a hundred feet of underground air pipe in the yards, which so lowered the receiver pressure as to cause the engine, which was air-controlled only, to run away and burst the flywheel, which was directly in line with a battery of large boilers. They, however, escaped injury.

The primary cause was undoubtedly oil in the pipes, which became volatilized and fired, either by heat or by electricity, the former being more likely.

There are three lessons to be learned from this accident, of which the most important is that an air-compressor engine should not be controlled by air alone, but should be fitted with an auxiliary governor which will act as soon as the speed rises above a certain point. In this way an accident to the tanks or piping, causing a sudden lowering of the pressure to a dangerous degree, would not cause the engine to race. The lowering of the pressure need not necessarily be caused by an explosion; the giving way of a pipe, valve or tank from any cause would have the same effect.

The second lesson is one that is being driven home by dozens of accidents all over the country, and that is, *keep an excessive amount of oil out of the system.*

The third and last lesson is one that is seldom needed, but which in this case was disregarded, though fortunately without serious result. It is that no engine should be so set that the bursting of the flywheel would be apt to crush the boilers.

ELECTRIC AIR DRILL RECORDS

Mr. Wallace F. Disbrow, superintendent of the Merry Christmas lead and zinc mine, Mineral Point, Wis., gives in Engineering-Contracting some interesting data on operating two electric air drills. These drills have been heretofore described in our columns.

The drill, mounted on a tripod or column, is actuated by air from a pulsator, which with an electric motor forms a complete actuating apparatus all under the eye and hand of the drill runner. The Merry Christmas mine has two of these drills. They are of the 4 D size, with a cylinder 4¾ in. diameter and 7 in. stroke. The drill is designed to carry 10 ft. of steel in drilling vertical holes. This makes the work done similar to that of a 2¾ in. steam or air drill.

These two drills have been operated in this mine for the past six months in a rather soft limestone formation. Although the rock was soft, it was exceedingly sticky and a heavy and gummy sludge was formed, making the drill work exceedingly difficult. In fact, so great is the influence of this factor in drilling, that formerly, with 80 lbs. pressure on the old style air drill, it was extremely difficult to put down a hole and extract the 6 ft. drill steel even when the hole was well watered. Mr. Disbrow states that "The electric air drills, with their powerful plunging stroke, are able to handle a 12-ft. steel down to the chuck without a stop if the machine is properly handled. In fact we have noted many times that when the hole was not sufficiently watered, the steel would still go down and keep turning, so that when the hole was finished, it would be almost impossible to extract the steel with a wrench."

This long stroke is an important factor in drilling holes wherever the sludge forms quickly, as the drill point thus helps to keep the bottom of the hole free of the sludge. With a short stroke the sticky sludge hangs much closer to the bottom of the hole, cushioning the blow, and sometimes stopping the drill. To keep the hole well watered in either case is a great help to the drill.

The drills in the Merry Christmas mine are not used continuously. Upon one occasion one drill put down 63 ft. of hole in two hours, the average depths of holes being 5 ft., making a record of 31½ ft. per hour. On another day a drill sunk two rounds of 12 holes each, to an average depth of 5 ft. For this work the drill was set up twice, as each round of holes were shot. This meant the drilling of 120 lin. ft. of holes, the time being 5½ hours, or at the rate of 21.8 ft. per hour, including making the extra set up.

The cost of maintenance of these two drills for six months has been about 20 cts. per day per drill. The principal parts to wear were chuck bushings, hose, front head cup leathers and chuck pins. The hose is the largest item of renewals, as soon as the slightest leak appears it must be discarded.

The cost of electric power for these drills has been with power at 5 cts. per K.W., for a single drill per day, $1.00, as about 20 K.W. is the average consumption of power.

NEW BOOKS

Compressed Air. Its Production, Uses and Application, by Gardner D. Hiscox. Fifth Edition, Revised and Enlarged, New York, The Norman W. Henley Publishing Company. 665 pages, 9½ by 6½ inches. Copiously Illustrated. Price $5.00. When a book makes its own way to a fifth edition, as this has, commendation is superfluous. Mr. Hiscox, who retained his full mental powers to within a week or two of his death, spent his last days of work in bringing the book up to date. This is a new edition throughout and the revision has extended to every page, eliminating obsolete matter and adding the later developments which have occurred in the various details of compressed air practice.

TRADE PUBLICATIONS

Air Compressors for Industrial Service, National Brake & Electric Company, Milwaukee, 24 pages and cover, 6 by 9 inches. This shows an interesting line of small, compact, motor or belt driven machines for general use, with tables of dimensions, capacities and other particulars.

Our New Product, B. F. Sturtevant Company, Hyde Park, Massachusetts, 16 pages and cover, 9 by 6 1-2 inches. This is Bulletin No. 158 of the Sturtevant engineering series, and deals with the multivane fan which is claimed to be the most efficient commercial fan in the world. A variety of applications are shown.

A FIGHT STOPS A DIVERS AIR SUPPLY

One of the horrors for a diver to reckon with must be the possibility of a stoppage of his air supply. A man working down in a Hell Gate wreck recently had a real experience of this character. Two men pumping air to him engaged in a desperate fight and the pump was stopped. When some other men realized the state of affairs they started the pump but could get no response by the life line. When the diver was hauled up he was unconscious and on removing his helmet heroic efforts were necessary to restore him. We may assume that he went on and took the risk again the next day the same as usual.

NOTES

A new system of Chinese weights and measures has been fixed by law. The unit of length is the "tchi," which is 32 centimeters, 12.6 in. For capacity, the "to" is 10.355 liters, 631.88 cu. in.; and for weight, the "lian" is 37.301 grams, 575.63 grains.

Diamond drilling on the Rand, according to an editorial in the *South African Mining Journal,* Oct. 10, 1908, apart from strengthening the knowledge that the Main Reef does go down, has not obtained adequate return for the vast sums that have been expended in such prospecting.

A handy formula for the horse power of falling water, assuming 80 per cent. efficiency for the wheel, is:

$$HP = hq \times .09$$

in which h is the effective head in feet, and q is the quantity of water in cubic feet per second.

By case hardening is meant the process of carburizing or converting the outer portion of a piece of iron into steel. This is done by heating the iron in contact with some carbonizing substance until a sufficient amount of carbon has been absorbed. The actual hardening is done by suddenly cooling the article in water.

A company has been formed at Buffalo to build a $20.000.000 drainage and power canal from Lake Erie at South Buffalo to Lake Ontario, providing that the federal government consents to the diversion of the water. Buffalo River, Smoke's Creek and Ellicott Creek, in the engineer's plan, will have their currents reversed and flow into the canal instead of into Lake Erie and Niagara River

Great confusion exists in a misuse of the word "ton." The unqualified term may mean the short ton of 2.000 pounds, the long ton, gross ton or English ton of 2.240 pounds, the gross ore ton of 2,688 pounds, the miner's ton of 2,500 to 3,000 pounds, the displacement ton of 35 cubic feet, the timber ton of 42 cubic feet, the shipping ton of 40 cubic feet, and a register ton of 100 cubic feet more or less.

The Cartago, the new steamer of the United Fruit Company, is provided with a refrigerating plant of ample capacity, and this is made to contribute to the comfort of the passengers. A push-the-button system is installed connecting the various rooms individually with the cold storage plant, so that no matter how hot the weather the passengers can regulate the temperature of their rooms to suit themselves.

A commission reporting to the Postmaster-General recommends that the pneumatic tubes now in use between main and branch offices in Boston, New York, Philadelphia, Chicago and St. Louis be continued under their present status; that is to say, that the government should not buy the tubes. The contracts under which the tubes are now used (for conveying mail matter) run for nearly eight years longer, and as the service appears to be still in experimental condition, five or six years hence will be soon enough for the government to think of acquiring ownership.

The latest and completest installation of the submarine bell signal system is undoubtedly that upon the new Ambrose Channel lightship which supersedes the Sandy Hook lightship at the approach to the harbor of New York. The bell is operated as usual by compressed air and is struck at regular intervals by a mechanism controlled by clockwork. The signal for this ship is the number 22. The bell strikes two and after an interval of three seconds it strikes two again; then after a silence of twelve seconds the strokes are repeated, and so on continuously.

Sapphires valued at $229,800 were produced in Montana in 1907. The blue sapphire in matrix was worked in the Judith River region in Fergus county. These sapphires, often called Yogo, range in size from minute crystals up to 4 or 5 carats. In color the Yogo sapphires range from light blue to the rich "cornflower" blue characteristic of the oriental sapphire. They make beautiful gems and are highly prized for their color and brilliancy. Probably over 90 per cent. of the sapphire is of good blue color and of gem quality. Occasionally purplish gems are found.

For the past year the Pittsburg & Westmoreland Coal Company has been dampening its mines by introducing steam into the air current at the fan forcing it through the mine in dry weather to prevent the roof from becoming unduly dry. The plan is reported to have worked well last winter and is again being used this year the idea being that of President H. A. Kuhn of the company. By this method the absorption of mine moisture by dry air from the fan is prevented in weather when the outside air is dry.

At Welaka, Florida, is what may be called a double well. It is 309 feet deep and has a casing 110 feet long. The well was first drilled to 160 feet, and from this depth ordinary "sulphur" water was obtained. The drill was then carried to a depth of 309 ft., where it encountered a strong mineral water, having a disagreeable salty taste. In order to use both kinds of water an inner tube was run nearly to the bottom of the well. Both this and the outer casing were connected with pumps, so that ordinary water and mineral water can be pumped at the same time.

Molybdenum is now produced in the fused state by the aluminothermic reaction. It is a metal of gray color, like steel, and has a dense structure. It contains as chief impurity about 1 or 2 per cent. or iron, besides very small quantities of silicon, so that its purity is 98 to 99 per cent. Molybdenum is also applied in the first place for making tool-steel, and is often used as a substitute for tungsten. The percentage in which molybdenum is used for such purposes is much smaller than that of tungsten.

The three big battleships recently launched in Great Britain, Bellerophon, Temeraire and Superb, will consume 3,650,000 lbs. of American lake and electrolytic copper, and 1,000,000 lbs. will be required for each of three more big battleships whose keels are to be laid in England. For account of the men-of-war on the stocks of Continental Europe, 19,000,000 lbs. of lake and electrolytic copper will be needed within a year. The mercantile marine contracts under way in European yards will consume 57,000,000 lbs. of copper within a year.

A committee, appointed by the Scientific Commission of the Aero Club of France, is about to institute experiments to determine who among its members is best fitted physically to resist the effects of high altitudes, and then a systematic effort will be made to penetrate into the zone of atmosphere lying 10,000 meters—32,000 to 33,000 feet—above the earth's surface. The ascensions concerned with this attempt have been called "physiological," because their principle object is to study the vital phenomena of the upper air. Apparatus for the inhalation of oxygen as "a gaseous cordial" will play an important part in the scheme.

An inland waterway 104 miles long is being dredged for the Mexican Government to connect the ports of Tampico and Tuxpan, on the Gulf of Mexico. It is 75 ft. wide and 10½ ft. deep and is only 2 to 5 miles from the Gulf throughout its length. Its purpose is to afford a safe channel for the many small craft engaged in the coastwise trade, which find rough weather and a bar at the mouth of the Tuxpan River a serious obstacle to their business. The United States has still only reached the talking stage for extensive work of this character along the Atlantic coast. The desirability and entire practicability of such proposed work is conceded.

Aluminum is gaining in popularity as a substitute for magnesium in flashlight photography. Its chief advantages is that it is obtainable in very fine powder—much finer than is possible with magnesium. The finest aluminum is that known as aluminum bronze, and is used for making "aluminum paint." The powder is much more easily ignited when mixed with one-and-a-quarter times its own weight of chlorate of potash, but the mixing must be very carefully done with a feather, as friction will sometimes cause it to explode spontaneously. The duration of the flash is about the same as that of magnesium, but the actinic value of the light is rather higher, chiefly on account of the more complete combustion of the fine powder.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

DECEMBER 1.

905,143. METHOD OF HUMIDIFYING AIR. William G. R. Braemer, Buffalo, N. Y.

905,210. PNEUMATIC PUMP. Caleb W. Moore, Vancouver, Wash.

905,211. AIR-COMPRESSOR. Caleb W. Moore, Vancouver, Wash.

905,291. METHOD OF OPERATING PNEUMATICALLY-DRIVEN FANS. John L. Creveling, New York, N. Y.

905,292. TRAIN FAN SYSTEM. John L. Creveling, New York, N. Y.

905,361. METHOD OF PRODUCING AND UTILIZING OZONE. Henry N. Potter, New Rochelle, N. Y.

905,387. WATER-SPRAYING DEVICE FOR PNEUMATIC TOOLS. Albert H. Taylor, Easton, Pa.

905,388. WATER-SPRAYING DEVICE FOR PNEUMATIC TOOLS. Albert H. Taylor, Easton, Pa.

905,582. AUTOMATIC AIR-BRAKE HOSE-COUPLING. Charlie W. Rhodes, Buena Vista, Va.

905,584. PNEUMATIC TIRE. Frederick Richardson, Providence, R. I.

905,640. AIR AND GAS COMPRESSOR. Herbert L. Borchers, Denver, Colo.

905,642. BICYCLE-PUMP. Harry C. Brooks, San Jose, Cal.

905,659. AIR-PRESSURE REGULATOR FOR PNEUMATICALLY-OPERATING MUSICAL INSTRUMENTS. Joseph Courville, Detroit, Mich.

905,692. PNEUMATIC HAMMER. Carl R. Green, Dayton, Ohio.

905,767. PORTABLE ACETYLENE-GENERATOR. Louis Troubetzkoy, Milan, Italy.

905,778. PRESSURE-INDICATOR FOR PNEUMATIC TIRES. Franh O. Wolff, Windsor, near Melbourne, Victoria, Australia.

DECEMBER 8.

905,861. ROTARY AIR-COMPRESSOR. Smedley J. Everts and Joseph E. Burris, Belt, Mont.

905,874. AIR-COOLING DEVICE. George W. Haverstick, St. Louis, Mo.

905,948. METHOD OF MAINTAINING A CONSTANTLY-OPEN FEEDING-PASSAGE INTO THE INTERIOR OF MOLTEN BATHS. Fritz O. Stromborg, Youngestown, Ohio.

1. The method of maintaining a constantly open feeding passage into the interior of a molten bath, consisting in providing a passage communicating with the interior of the bath, and constantly maintaining in said passage *fluid under pressure* in excess of the pressure of the head of the bath but only sufficient to cause a slow bubbling of the pressure fluid through the bath.

905,967. ROTARY BLOWER OR GAS-PUMP. John T. Wilkin, Connersville, Inds.

905,973. MECHANICAL PRODUCTION OF HIGH VACUUMS. Joseph Zeitlin, South Kensington, England.

906,165. PNEUMATIC CARPET-CLEANING MACHINE. John F. Rudd, Kansas City, Mo.

906,234. SUCTION-DREDGE OR THE LIKE. Franklin H. Jackson, Berkeley, Cal.

906,275. APPARATUS FOR CARBURETING AIR. Seymour W. Peregrine, Portland, Me.

906,285. VALVE FOR AUTOMATICALLY AND INTERMITTENTLY INTERRUPTING A CURRENT OF GAS OR LIQUID Gustaf von Post, Stockholm, Sweden.

906,309. AIR-RIFLE AND THE LIKE. Henry A. C. Schobbert, Stamford Hill, London, England.

906,395. COMPRESSED-AIR WATER-ELEVATOR. Robert M. Downie, Beaver Falls, Pa

906,406. AEROPLANE FLYING-MACHINE. Thomas H. Gignilliat, Savannah, Ga.

DECEMBER 15.

906,532. METHOD OF PURIFYING MILK, CREAM, AND OTHER LIQUIDS. Wiggo F. Jensen, Topeka, Kans.

906,559. SELF-PROPELLED AIR-SHIP. Georg Pum, Vienna, Austria-Hungary.

906,570. AUTOMATIC COUPLING FOR AIR-PIPES. Clarence Sheeler, Coatesville, Pa.

906,585. CLUTCH-OPERATING MECHANISM. Harry L. Turney, Portland, Oreg.

906,659. COMBINATION PUMP AND COMPRESSOR SYSTEM. Walter J. Richards, Milwaukee, Wis.

906,733. WELL-BLOWER. Joseph H. McEvoy, Houston, Tex.

906,741. TUNNELING-MACHINE. Joseph Retallack, Denver, Colo.

906,764. MEANS FOR OPERATING THE RETAINING-VALVES OF AN AIR-BRAKE SYSTEM FROM THE ENGINE. Harry P. Zackey, Martinsville, N. Y.

906,808. FLUID-PRESSURE ENGINE. William T. Lewis, Columbus, Ohio.

906,833. PNEUMATIC SAFETY APPLIANCE OF CARS. Albert J. Thornley, Pawtucket, R. I.

906,850. PNEUMATIC SURFACING-MACHINE. George L. Badger, Quincy, Mass.

906,923. PNEUMATIC CUSHION. Vaclav H. Podstata, Dunning, Ill.

907,041. MOTIVE-FLUID-OPERATED ROCK-DRILL. Charles M. Hampson, Denver, Colo.

907,054. REGULATOR FOR AIR-COMPRESSORS. George W. Hunneyman, Concord, N. H.

907,096. PORTABLE PNEUMATIC DRILL. Andrew P. Strom, Cleveland, Ohio.

DECEMBER 22.

907,120. AERIAL MACHINE. Henry S. Booth, Manchester, England.

907,180. COMPOSITION FOR PURIFYING AIR. Herbert Ryder and Lyndon C. Wilson, Newark-on-Trent, England.

907,236. COW-MILKING MACHINE. Arthur V. Hinman and Ralph L. Hinman, Munnsville, N. Y.

907,341. HYDRAULIC AIR-PUMP. Albert S. Gray, Grand Rapids, Mich.

907,356. SUBAQUEOUS TUNNEL. Olaf Hoff, New York, N. Y.

907,357. METHOD OF SINKING SUBAQUEOUS TUNNELS. Olaf Hoff, Tarrytown, N. Y.

907,392. ASPIRATOR. Charles W. Nance, Sydney, New South Wales, Australia.

907,407. SUBAQUEOUS ROCK-BREAKER. Charles L. Rowland, New York, N. Y.

907,430. DRILL-HOLE-CLEANING ATTACHMENT FOR HAMMER-DRILLS. Daniel S. Waugh, Denver, Colo.

907,446. ACETYLENE-GAS GENERATOR. Charles L. Betts, New York, N. Y.

907,474. COMPRESSED-AIR ENGINE FOR CONDUIT WIRE-DRAWING. Harry C. Dickinson, Mobile, Ala.

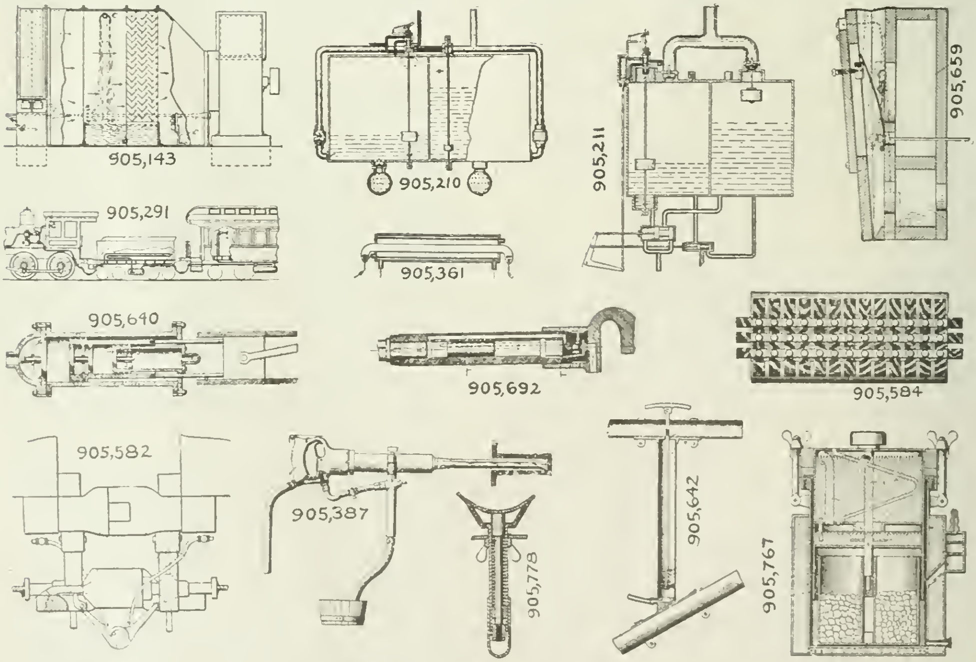
907,591. AIR-PUMP. James J. Gilday, Berringa, Vivtoria, Australia.

1. An improved pump comprising a revoluble cylinder having one or more internal screws attached to or formed integral therewith, said screw or screws having a gradually increasing pitch from the air intake, a central core formed integral with said screw or screws tapered from the air outlet, an axle on said core journaled in removable bearings on a stationary casing around the cylinder, an inlet pipe attached to said casing and a gland between the latter and said cylinder substantially as set forth.

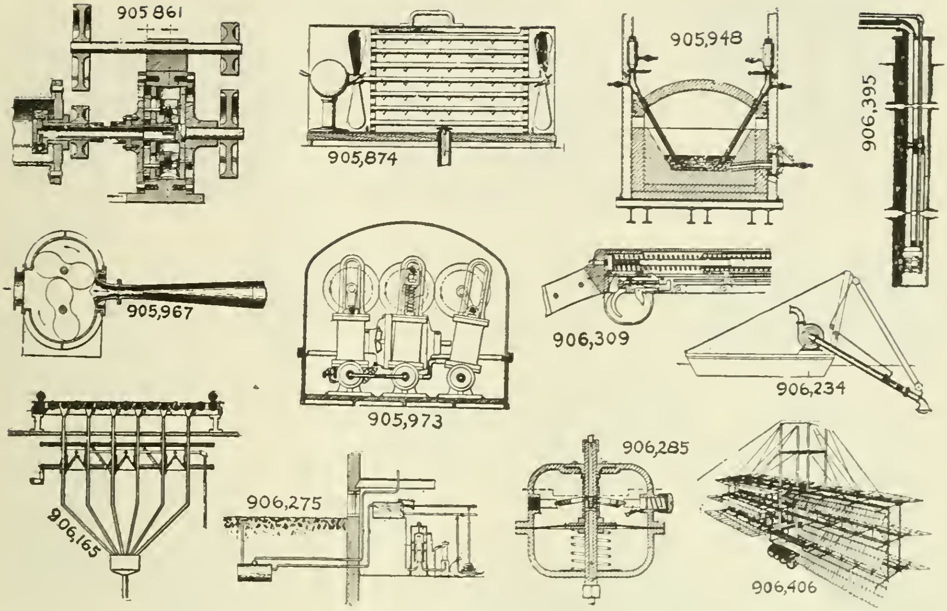
907,633. AIR-WASHING APPARATUS. Louis Narowetz, Chicago, Ill.

907,686. AIR-BRAKE APPARATUS. Charles E. Duffie, Omaha, Nebr.

907,694. MEANS FOR OBSERVING DUST-LADEN CURRENTS OF AIR. David T. Kenney, North Plainfield, N. J.



Pneumatic Patents, Deceeber 1.



Pneumatib Patents, December 8.

DECEMBER 29.

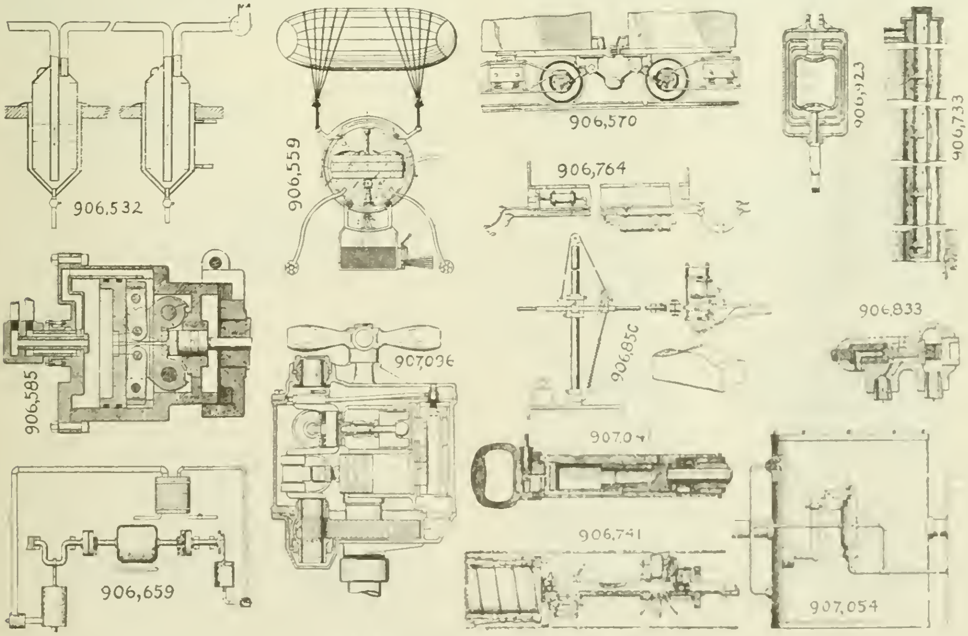
907,853. PRESSURE-APPLYING MACHINE. David A. Murphy.

907,859. AIR-COMPRESSOR. Christian Neumann, St. Louis, Mo.

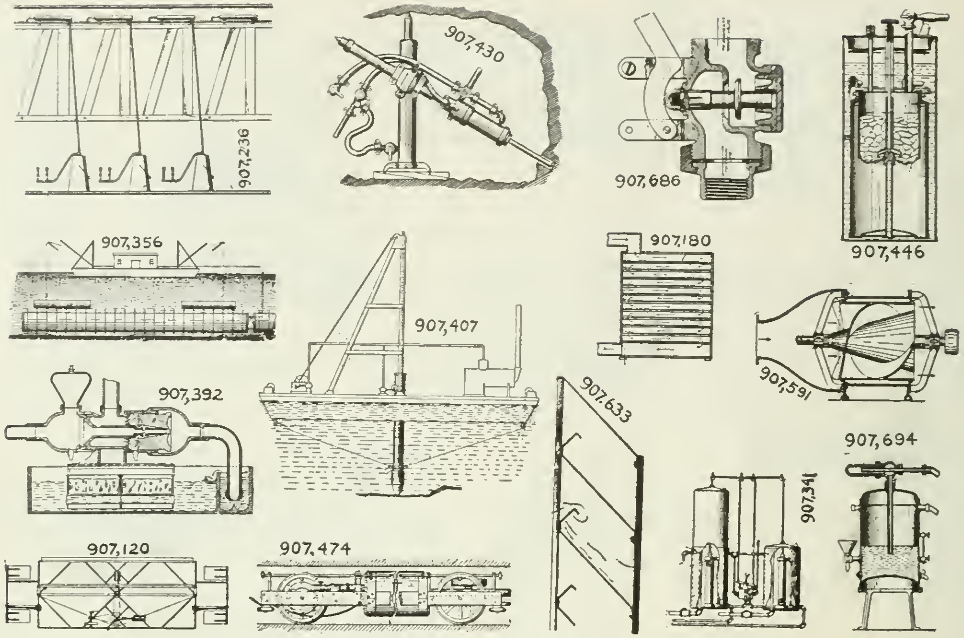
907,884. MOTOR-COMPRESSOR. Walter J. Richards, Milwaukee, Wis.

907,992. AIR-SHIP. Max Grube, Oakland, Cal.

908,002. MOLDING-MACHINE. Charles Herman, Allegheny, and Martin L. Heyl and Harry T. Frauenheim, Pittsburg, Pa.



Pneumatic Patents, December 15.



Pneumatic Patents, December 22.

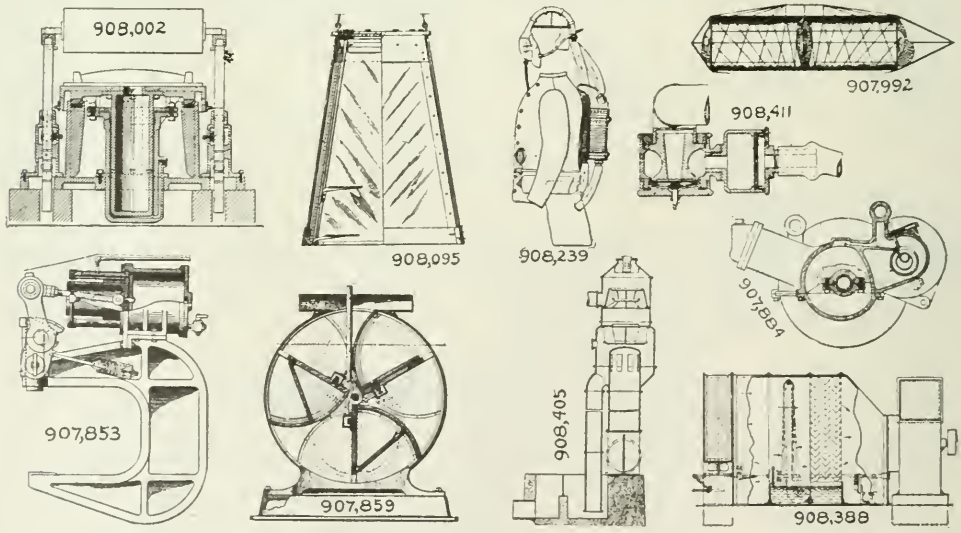
908,095. DIVING-BELL. Edward J. Hassan, East Haven, Conn.

908,239. RESPIRATORY APPARATUS FOR USE IN COAL-MINES AND LIKE PLACES. William E. Garforth, Normanton, England.

908,388. AIR-PURIFIER. William G. R. Braemer, Buffalo, N. Y.

908,405. BAROMETRIC CONDENSER. Axel H. Helander, Pittsburg, Pa.

908,411. COMPRESSED-AIR TALKING-MACHINE FOR PHONOGRAPHS, GRAMOPHONES, AND OTHER SPEAKING-MACHINES. Henry Joly, Paris, France.



Pneumatic Patents, December 29.

COMPRESSED AIR MAGAZINE
EVERYTHING PNEUMATIC.

Vol. XIV MARCH, 1909 No. 3

A LITTLE JOB OF PNEUMATIC SUBAQUEOUS TUNNELING

An interesting narrative of practical engineering was comprised in a paper by Herman W. Spooner, of Gloucester, Mass., read before the New England Water Works Association. The following is abstracted and much condensed from the paper referred to.

The contract required the construction of two vertical masonry shafts, interior diameter 11 ft., one on each side of a canal, the shafts to be surrounded to within a few feet of the surface by steel cylinders, and a tunnel 9 ft. interior diameter, having a brick wall 1 ft. thick encased in a cylinder of steel plates, was to be constructed between these vertical shafts.

A circular excavation was begun for the easterly shaft, sheathed with matched plank 2 in. in thickness, the sheathing being supported by rings of 4-in. channel, leaving an opening in the clear of 13 ft. 9 ins. in which to operate. At a depth of 10 ft. boulders were encountered in the coarse gravel, which were removed after blasting; water immediately began to enter the excavation in small volume and was removed by a 3-in. pulsometer pump. At a depth of 18 ft. a decided change was noted in the material, fine dead sand being found, and a decided increase in the quantity of water was evident.

When a depth of 19 ft had been reached, the shoe-piece of the cylinder, with a special reinforced cutting edge upon which the masonry lining wall was to be constructed, was placed in position within the sheating and a second section of the cylinder was then adjusted, and so on. In the sinking of the cylinder the usual and some unusual difficulties were encountered. The volume of water entering the excavation rapidly increased, and as the tide turned the laborers were obliged to leave the bottom on account of the absence of pumps of sufficient capacity.

It was the intention of the contractor to complete the work without the use of compressed air, treating the ground through which the work was to be built with cement grout, this method being less expensive and having been used to advantage in other and similar work. Here, however, it was found that the nature of the gravel was such that the ground waters at all times moved freely through the ground, so that there was no opportunity at any time to leave grout in place for a sufficient period to allow of its attaining the initial set; therefore the contractor decided to resort to the use of the pneumatic method of construction. At this time the bottom or cutting edge of the cylinder was about 7 ft. below low-water mark, it being necessary to lower the structure about 20 ft. further before the required depth was reached. During the next two days the cylinder was worried down to a bed consisting of very coarse, hard gravel and isolated to a depth of 28 ft. below the surface of the park.

A recess was cut in the concrete lining to receive the wooden deck which was to support the compressed air tube and lock, and work in the east shaft was abandoned until the apparatus, air compressor, additional boilers, etc., could be assembled.

The cylinders to be placed within the excavation on the west side of the canal were rolled across the drawbridge and placed in correct order inside the sheathing. The inside of this cylinder was treated in the same manner as was the one on the opposite shaft and the walls constructed of concrete, an air deck, 18 in. in thickness, being built into the walls as the work progressed.

The pumping apparatus was moved to the west shaft and an attempt made to work this cylinder to a greater depth than was reached in the east shaft, but when a level had been reached which was within a fraction of an inch of the level of the bottom of the first shaft, the contractor was forced to abandon operations and wait for the application of compressed air.

While work was being carried forward on the westerly side of the canal, a small compressor with a receiver had been installed near the derrick on the east side of the canal, and on May 27 the air-lock and tubing especially designed and built for this work arrived and were ready, together with the head-house, and in operation, four days thereafter. Previous to this time there had been very little continuous work, and as when using the pneumatic method there is a continuous expense to maintain a dry excavation, two shifts were organized. Each shift worked eleven hours and consisted of foreman, stationary engineer, fireman, lock-tenders, miners, tenders, and muckers, generally eleven men being employed during each shift. The men employed upon this work were of the first rank in their several vocations, exercising great care in the performance of the duties assigned to them, and on this account, if for no other reason, the writer is pleased to be able to state that there were no men injured during the execution of this contract, and the final result is entirely satisfactory.

The air compressor was in operation thereafter continually until the work was nearly completed. All materials were removed, and all materials required in construction were transferred, through the air-lock, thus increasing the cost of construction nearly four-fold.

The cylinder was bound in such a manner that although the gravel was excavated from beneath the cylinder to a depth of 3 ft. and additional weight was added in the form of water on the deck and piles of brick upon the rim, it did not drop until all the air-pressure had been removed and the earth at the sides of the cylinder commenced to heave inward. This passage of gravel or "heave" from around the cylinder and about the sheathing down and into the void excavated, and into which it was desired to drop the structure, caused trouble throughout the entire lowering of this shaft, also until the tunnel was completed about 10 ft. from the side or eye. Often after working for an entire shift, when air pressure was removed, a net gain in depth of only 1 ft. was made, while at other times only 3 ins. were gained.

Poling boards were used beneath and in the rear of the cutting edge to hold back the material, which had a decided tendency to heave, but with little effect. In some instances over 4 ft. of sand and gravel rushed in when the pressure was removed, requiring nearly an entire shift of work to remove it.

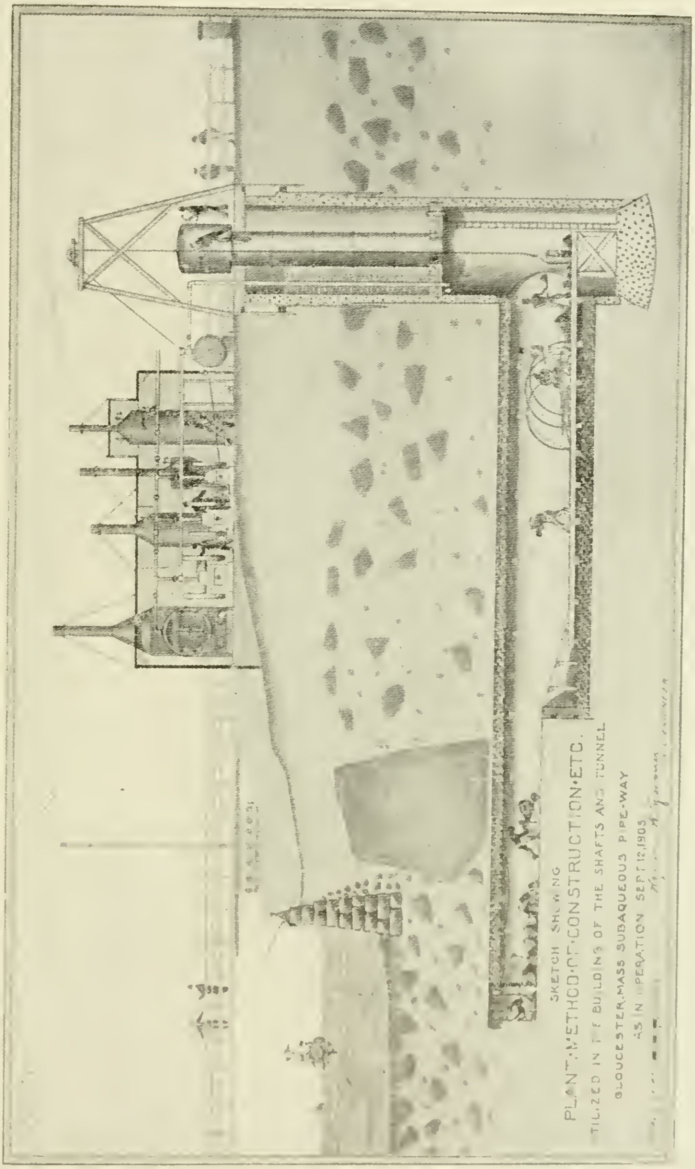
In order to increase the weight of the cylinder, hundreds of tons of pig-iron were placed upon the deck and walls in the endeavor to drive the cylinder down, but even under this added weight it still remained firm.

The sand used as a guide had shifted and the surrounding ground settled or slumped, carrying sheathing and channel-iron rings with it to such an extent that the head-house was unstable, a cavity extending nearly 10 ft. from the cylinder in all directions being open Heavy timbers were placed to span the hole and support the superstructure, these being held together with heavy chains.

It was decided at this time to drive a square set of sheathing outside the circular set originally placed, in an attempt to reach the channel-iron rings which were evidently jammed between the steel cylinder and the original sheathing; also to support the earth and prevent further caving. This was accomplished with considerable difficulty, it being found that the rings were in close contact with the cylinder, being much lower on one side of the cylinder than on the other; also that the heads of a few of the rivets used in making the joints of the cylinder had been entirely cut or scraped off as it had slid through the ring. Two rings were cut and the accessible portions removed, after which a boulder that had slid in and bound against the cylinder was broken and removed.

The work of excavating was recommenced beneath the cylinder after sections of the tube leading from the air-lock to the deck had been placed in position, and the cylinder was lowered after continued and discouraging efforts, as at no one time did it go down more than 20 ins.

Grade lines were drawn across the cylinder and preparations made for a final drop to the required grade. After the air pressure was removed the structure settled gradually, and


SKETCH SHOWING
PLANT·METHOD·OF·CONSTRUCTION·ETC.
UTILIZED IN THE BUILDING OF THE SHAFTS AND TUNNEL
GLOUCESTER, MASS SUBAQUEOUS PIPE-WAY
AS IN OPERATION SEPT 12, 1905

SKETCH SHOWING METHOD OF CONSTRUCTING SUB-AQUEOUS PIPEWAY AT GLOUCESTER, MASS.

when the desired point was reached, the air pressure was applied, but before there was sufficient pressure to counteract the weight, it had settled nearly 1 ft. below the line.

A space was immediately excavated below the cutting edge and poling boards placed in such a position as to allow for the placing of a concrete foundation of much larger diameter than the cylinder. The center of the excavation was dished to a depth of 8 ins. below the sides or ends of the poling boards, the material at the bottom and upon which the foundation was placed consisting of a mixture of coarse and fine hardpan gravel, in which, on account of its firmness, it was difficult to make an impression with a pick.

A pressure of 17 lbs. was maintained while depositing the concrete for the foundation, placing the water-proofing, and until the whole mass had firmly set: the cavity around the shaft was filled and preparations made to extend the walls of the shaft upward.

The power plant upon this work July 1 consisted of three boilers, including the one used in connection with the hoisting engine, all being piped together and making a total of 50 h. p. to operate the hoisting engine and compressor. At this time it was decided to make a trial of the use of cement grout to harden the ground through which the tunnel was to be driven. A small 2-in. opening was made in the steel cylinder in the upper part of the eye which was 12 ft. in diameter, and which had been left free from concrete when the walls were formed. A thin mixture of grout was prepared and an attempt made to force it into the sand and gravel surrounding the steel casing, but after several attempts the idea was abandoned, as it seemed, under existing conditions, impracticable, it being only possible to solidify a very small section of the material directly surrounding the delivery point of the grout.

As the excavation was progressing at the different levels, corresponding to those through which the tunnel was to be driven, careful examination was made, with the result that when it was found that the solidification method was impracticable, recourse was had to the original method of using steel plates to support the earth above and upon the sides of the tunnel, while the masonry walls were placed with the aid of compressed air. A supplementary agreement was drawn and the contractor granted permission therein to use steel plates in place of ring timber, provided that the masonry walls, including the waterproofing and plaster, were constructed to a minimum thickness of 18 ins., a thickness equal to the proposed ring-timber and brick wall. This agreement was signed, plates ordered, and preparation made to cut out the eye. On July 3 a 50 h. p. upright boiler was added to the existing plant.

The work of cutting the steel cylinder progressed very slowly on account of the disadvantages under which the men labored, the positions necessarily occupied in holding and striking the points being decidedly awkward. After about 170 hours of continuous work by entire shifts with diamond points, a part of the upper portion of the eye was removed and it became evident that the channel-iron rings which were mentioned as having been used as a support for the original sheathing were to continue to disturb operations. Directly across the opening made in the side of the cylinder two of the rings were found twisted completely around each other, having been carried down at least 18 ft. while in close contact with the cylinder, thus causing the friction which retarded the settling of the cylinder. The sections of rings spanning the eye were cut out and the excavation continued.

On July 12 the need of an addition to the air compressor plant was noted, as the small machine delivering about 300 cu. ft. of air per minute seemed to be inadequate, the temperature in the heading rising to such a degree that an effort was made to cool the air with water and ice previous to sending it into work, and thus enable the men to work freely. The opening in the top of the eye was only 18 ins. in depth at this time, and on account of the loose nature of the ground the single compressor was working to its full capacity in order to maintain sufficient pressure to keep the water away from the breast.

A few small boulders were encountered in this first opening, which were removed without difficulty. For four full days, or eight shifts, the men labored in excessive heat, depending upon the one compressor, and succeeded in driving the arch of the tunnel a distance of four plates, or 4 ft. from the side of the vertical shaft. After two more rings were added it was decided to suspend operations and seal the heading with clay until another compressor could be installed, as it was decidedly dangerous to excavate further and depend on the one compressor then operating at its full capacity to maintain the required pressure.

On July 22 another compressor, originally designed for high-pressure, capable of delivering about 800 cu. ft. of air per minute was installed and in operation, working in conjunction with the other, and the work was again rushed forward.

The contractors at this time realized the necessity of still further increasing the plant by the addition of another boiler, as the three small boilers on the work were taxed nearly to their entire capacity. When the arch had been driven a distance of 8 ft. the needle-beam, consisting of a timber 10 ft. in length, 12 ins. square, was placed in position, and the work of removing the lower half of the eye of the cylinder was commenced. The plate-joints and breast were completely covered with successive coatings of clay to hold the air, and even then it required the operations of both compressors at a high speed to maintain sufficient pressure, the thermometer registering 100 degrees in the heading and 90 degrees in the lock. The continuous labor (eleven hours) in humid compressed air at such high temperature began to affect the laborers and they were obliged to come out through the lock at intervals for change of air. On July 27 the brick masons laid the first section of invert and completed the arch and work around the eye on July 29, laboring in the intense heat nearly 45 hours to complete the section 6 ft. in length.

A temporary bulkhead of plank and bags of clay was placed in the invert at the end of the completed section, and the heading again opened. While this work had been progressing, another boiler (capacity 150 h. p.) had arrived, the entire plant being connected and in working order on August 3; the heading had now been extended a distance of 12 ft. through coarse gravel and boulders. At this time the larger of the two compressors became jammed and was out of commission for a few minutes, the whole load resting on the small compressor. During the strain this compressor turned 140 revolutions per minute, and although the pressure gradually dropped, the single engine held sufficient pressure until the defect was repaired and both were running.

It was evident to the writer that there was not sufficient duplication of plant upon the work, and in consequence he requested the contractors to still further add to the existing plant a compressor delivering at least 1,100 cu. ft. of air per minute. Under the conditions, it was unsafe to carry on operations in the heading, not only on account of the danger to the laborers, but also on account of the danger of loosening or the caving in of the breast and the loss of time in again recommencing operations.

The contractors kept in touch with the work, and knowing well the delicacy of the operation of driving the tunnel through the coarse gravel and stray boulders that might be encountered, suggested a decided change in the method of construction. Under the bed of the canal the roof of the tunnel was to be constructed within 11 ft. of low-water mark, the bed of the canal being practically dry at low tide. The amount of material above the work was deemed insufficient to hold sufficient pressure to allow for the construction of a full section of the tunnel wall; therefore it was decided that when the completed walls had been erected to within a safe distance of the canal, the upper half or arch should be driven and the arch wall completed under and as far as the westerly side of the canal to a point beneath the retaining wall.

The last addition to the plant consisted of a large low-pressure compressor, having a capacity of 1,100 cu. ft. per minute, and it was installed and in operation on Aug. 23. It was found that the difference in the temperature in the tunnel was about 20 degrees, being much lower than when the air was supplied by the small compressors; it was also noted that sufficient air could be supplied by the new engine with half speed on the second machine, allowing for repairs on the third or smallest engine.

At a point about 56 ft. from the easterly shaft a temporary bulkhead was erected, filling the bottom of the tunnel or invert to within a few inches of the spring line, composed of a brick wall 12 ins. in thickness and backed by clay puddle. This dam or bulkhead remained in place until the arch walls were completed under and beneath the western walls of the canal. During the construction of this arch about 9½ pounds of pressure was sufficient to carry on the work. When the tunnel had been driven to a point within 20 ft. of the easterly canal wall a slight leakage of air was noted in the waters passing through the canal. This disturbance continued to increase as the work was extended, and when it had progressed to a point directly beneath the canal, the air rushed up through the waters in such volume from the heading that the canal for its entire width and a distance of 50 ft. up and down stream resembled a boiling caldron, which was watched with much interest and speculation by large numbers of people from the bridge.

The work of driving the arch had progressed only a few feet when a boulder was uncovered in the roof extending across the heading for a distance of 5 ft. and hanging into the opening about 2 ft. A few light charges were fired in small hand-holes made on the under side of the boulder, but no marked effect was made. Drilling and splitting was then commenced, and after nearly a week of continuous work the roof-plates were made secure beneath the stone, a sufficient amount of the boulder having been removed. Several small boulders were found, split, and removed from the heading, remaining in the completed tunnel until the air deck was removed, as they were too large to move through the lock.

During the progress of this part of the work the ground occupying the position of the invert remained undisturbed, the bench or ground below the spring line being covered with a layer of clay 6 ins. in thickness, having an overlayer of boards. It was quite a difficult task and required continuous watching to keep the pressure at an amount sufficient to keep the water from entering under and through the clay floor, and again not enough to lift the canal bottom and cause a blowout, it being necessary to watch the rise and fall of the tide and regulate the pressure according to its different levels.

During this part of the work the smallest error in air pressure could but result in severe monetary loss to the contractors and possibly the loss of the lives of the men employed in excavating the heading. The materials excavated were coarse sand and gravel, through which the air rushed freely when not retarded by the coating of clay applied from within, and was removed from its original position by small trowels. This gravel, after being dug out with the trowels and dropped on the bench, was shoveled into a single wheelbarrow and transferred to the shaft. Here it was again shoveled into a bucket to be lifted into the air lock. From the lock it was dumped into carts and hauled to the dump. Thus it will be understood that the gravel excavated was handled five different times before being finally dumped, making the expense heavy.

Several times during the perilous part of the work on the arch, the earth was driven upward by the air pressure or fell away, leaving a large aperture through which the air roared to the surface. During these periods the whole compressor plant was operated to its entire capacity; these voids were immediately filled with clay, bags, or any cloth or material which would stop the outrush of air, the miners knowing that were these voids not filled at once the pressure would relax and the waters from the canal and the harbor rush in. On September 21 the arch was completed to a point about 14 ft. from the western shaft and beneath the westerly side wall of the canal, and a solid brick bulkhead erected. This bulkhead was built within the completed arch and about 1 ft. back from the toothing, thus leaving sufficient brickwork for conection with that part of the tunnel which was to be built from the westerly shaft.

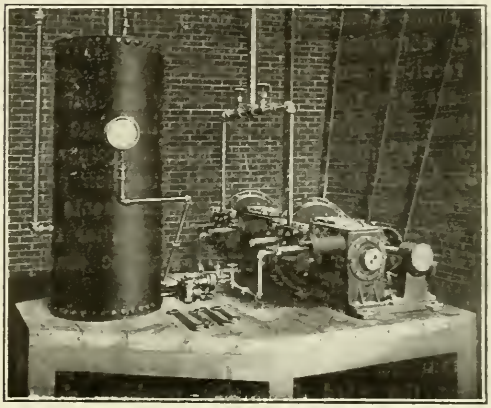
The first temporary brick bulkhead was now removed and the invert constructed, the connection between the arch and invert being made tight by splitting brick in form of a wedge and driving tight. This being neatly executed, the circular section was made complete to the terminus of the work to be accomplished from the east side. The bulkhead having been completed and braced by heavy raker timbers stepped into the brick invert, the air pressure was removed and the air tube and lock transferred and fastened in position in the west cylinder, the air and water supply pipes were suspended over the canal, the head-house placed in position, and the work of settling the western shaft commenced on October 6.

The west cylinder, having timber guides, settled rapidly, the cutting edge being kept in contact with the bottom, slipping down when the air pressure was slightly reduced; thus the trouble of the heaving of gravel, as was experienced in sinking the east shaft, was avoided, and on October 9, 12 ft. of progress downward had been accomplished. On October 13 the cylinder reached the required level and the concrete walls were extended upward toward the surface. The excavation was made and foundation placed similar to that in the east shaft, and the work of cutting out the eye of the tunnel in the steel cylinder commenced. The levels and lines were transferred through the deck and preparations made to excavate for the arch. This work was commenced on October 19 and six days thereafter the toothing of the completed section and bulkhead was met, and on October 30 the continuous walls of the tunnel were complete from the east to the west shaft. The work of calking, cement washing, and finishing was begun immediately after the bulkhead was removed, the fires were drawn in the larger boiler and it was removed. On November 4 the night shift was discharged, the work thereafter being carried on by one gang during the day. Three days thereafter the air pressure was withdrawn, and the writer was gratified to note that there were very few damp spots throughout the entire length of the tunnel.

COMPRESSED AIR CLEANING TEXTILE MACHINERY

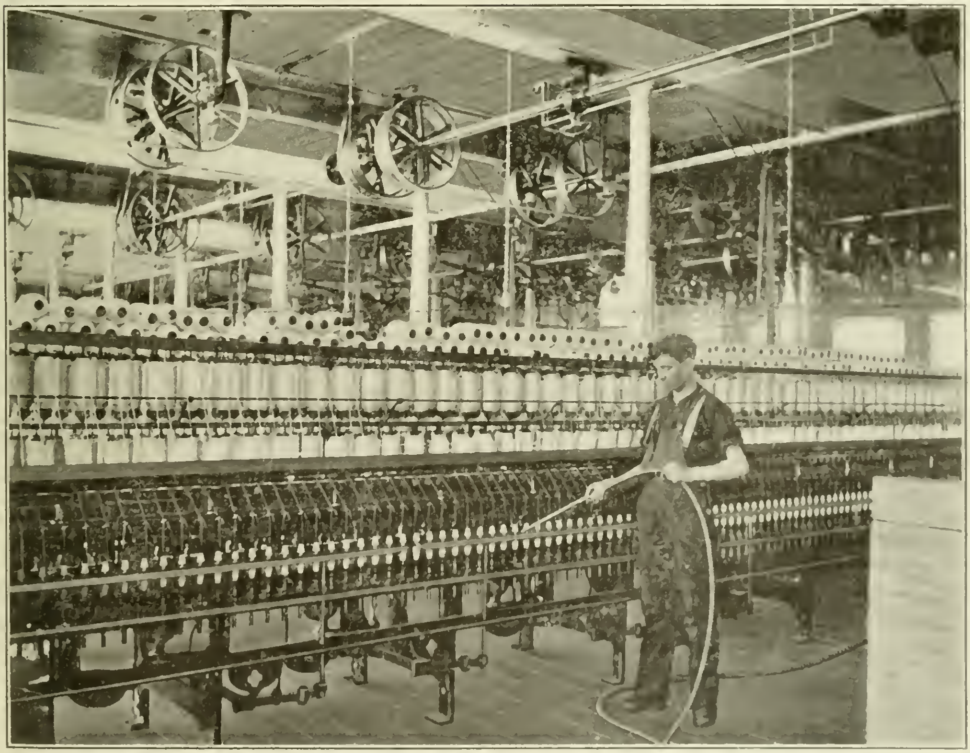
Compressed air is so handy, so efficient and economical for cleaning machinery, that the industrial establishment without a compressor plant even for this service alone is deficient in an important detail of successful operation. Especially in textile mills where the highly inflammable lint and dust accumulates on the machines and walls is the thorough and systematic removal of such material important, and no more efficient means has been found than a jet of compressed air.

The half-tone, Fig. 2., shows the cleaning of a spinning frame in a New England cotten factory. Although only one boy is seen, two boys work together, one on each side of the machine, so that when one side is being cleaned the dust will not settle on the other. Each frame as here shown has 256 spindles; it takes the boys seven minutes to clean one frame, and they clean seven frames an hour.



COMPRESSING PLANT FOR AIR JET.

Fig. 2 shows the special compressing plant



CLEANING SPINNING FRAMES WITH AIR JET

for this service, built by the Westinghouse Air Brake Company. It comprises two belt driven compressors with automatic governor, air receiver and appurtenances. The compressors are the same in nearly all details as those furnished with the Westinghouse air brake equipments, being simple, compact, easily installed, requiring little attention and generally well adapted to the requirements of this service. By the use of the governor the operation of the compressors may be made entirely automatic.

The suction of the compressors is piped to the outside atmosphere where cool dry air is obtainable. The main compressed air pipe crosses the yard from the machine shop where the compressors are located, there being about 20 feet between the buildings, and in this space a cooling coil is installed for condensing all moisture possible, and a trap is placed in the line inside the factory, all excess of moisture being thus removed.

For textile mills about 40 lbs. air pressure is found to be most satisfactory. Air higher than this is likely to break the yarn or to disseminate the dirt in small particles to produce soiled spots. The use of higher pressures also increases the cost of compression.

HUMIDITY AND MINE EXPLOSIONS*

By Carl Scholtz.

During November and December, 1907, four serious mine explosions occurred in the Appalachian coal field, which resulted in the loss of nearly a thousand lives and caused an enormous damage to property.

An examination of the various reports concerning these accidents indicates that the explosions were caused by the ignition of gas or dust: they show the point of origin and the direction in which the force was expended, and give a detailed description of the damage done. Very little has been said as to what should be done to prevent these explosions, and the object of this paper is to give the result of several years' observation of conditions which I have noticed during 15 years' connection with coal mines in various fields of the United States.

The striking features developed by these investigations are:

1. Explosions occur more frequently in the colder months of the year; the colder the winter the more frequent the explosions. If a certain district has extremly cold weather and other sections of the country are comparatively warm, the latter sections are freer from explosions.

2. Mining fields located in higher altitudes are more productive of explosions than those at lower elevations.

3. The hygrometric condition of the atmosphere has the greatest effect upon the cause of explosions.

Every practical mining man knows that the majority of explosions take place between November 1 and March 15. It is well to say here that there are many explosions of a minor character which result in no loss of life, or perhaps one single death only, of which but little is published in the daily or technical press. Every mine examiner instinctly feels danger when he enters the mine on a cold crisp morning.

The fact that altitude and general climatic conditions enter into mine explosions can very readily be verified by an examination of the weather reports showing the general climatic conditions which existed in the various localities when accidents happened.

The principal fields of mine explosions in the bituminous districts are Pennsylvania, the eastern portion of West Virginia, Alabama, Oklahoma, and Colorado; and since coals produced in these fields are high in volatile matter and low in moisture, it is very clear that the chemical composition of the coal has much to do with the generation of mine gases and coal dust.

In examining the records of explosions in West Virginia, it will be noted that most of them occur during unusually cold weather, and but few in the warm season when the trees are in full foliage. In Oklahoma the record indicates that the greatest number of explosions have followed an unusually dry season. It should be noted that this portion of the country is not densely timbered, and contains but limited bodies of flowing water. The same condition applies to Colorado to an even greater extent.

The two conditions above mentioned, when taken in connection with the visible results which they create in the mine by the deposit of excess of moisture during the wet season, or when humidity is high, and the creation of dust during the winter months or the very dry season, undoubtedly lead us to believe that the hygrometric conditions of the ventilating currents have much to do with mine explosions; and since this is a matter which can be controlled without much expense, it is believed that the application of a vaporizing system in mines which are dusty and generate firedamp will prove, at least in part, a remedy.

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*From a paper before the American Institute of Mining Engineers, Birmingham Meeting, October, 1908.

After examining many text-books and reports, I noticed that very little reference is made to the hygrometric condition of the atmosphere in connection with mine explosions. Some of the more recent publications refer to the advisability of ascertaining the moisture in the air, but do not state the effect which humidity has, and how the required degree of saturation should be brought about. That humidity in a mine-ventilating current is desirable and necessary, is generally understood, and is emphasized by the recommendation usually made by mine inspectors that roadways be sprinkled with water in order to settle the dust. The adoption of appliances to settle the dust will prove the best safeguard against mine explosions.

Observations indicate that when the outside temperature ranges from 75 degrees to 90 degrees F., the inside temperature fluctuates from 72 degrees to 76 degrees F. In the winter, when the outside temperature ranges from 30 degrees to 55 degrees F., the inside temperature ranges from 60 degrees to 64 degrees F. In the summer, when the warm air-current enters the mine, the temperature falls, upon coming in contact with the cold ribs along the entries, and the excess vapor is deposited as sweat on the roof and the roadways, so that no dust exists. The mine, of course, becomes drier nearer the upcast, since a part of the humidity is absorbed by the freshly-mined coal. In the winter, when the inside temperature is higher than that of the air outside, the cold ventilating current, upon warming and expanding, absorbs all the moisture available. If there is no water available, the relative humidity in the air-current is very low. For the purpose of illustrating this more clearly, the following data, representing actual readings, will be of interest:

With an outside temperature of 80 degrees F. and relative humidity of 75 per cent., at a barometric pressure of 29.2 ins., a ventilation current of 75,000 cu. ft. per min. carries into a mine, invisibly suspended in the air, during a period of 24 hrs., 15,200 gals. of water. Upon cooling to a temperature of 75 degrees F. not only would the mine current be completely saturated, but there would be deposited in the mine nearly 1,000 gals. of water per day. In the winter, however, with a temperature of 32 degrees F. and a relative humidity of 95 per cent., upon entering the mine and warming to 62 degrees F., the relative humidity of the ventilating current is diminished to 33 per cent., unless an opportunity is given for the air-current to absorb more moisture from running water or other sources. In order to saturate completely this warmed air-current of 75,000 cu. ft. per minute, about 9,000 gals. of water per day are required. This is the reason why dust is generated in the winter in the better-ventilated mines, and the assumption is well borne out by the accident at the Monongah mines, which had a ventilating efficiency of the highest order. The more cold air forced through a mine in the winter, the drier will that mine become: the more air forced into a mine in the summer, the more mosture will be deposited along the intake entries, and where the roof is slate, the more difficulty will be experienced in keeping up the top. It is also well known that humidity in the air has an effect upon the ignition of gases, because the fine particles of water invisibly suspended in the atmosphere absorb much of the heat in combustion. For comparison, it may be said that an air-current of a temperature of 62 degrees F., fully saturated with moisture, requires approximately 7 per cent. more heat units (British thermal units) than dry air to reach a temperature of 1,213 degrees F., which is the point of ignition of firedamp.

A water-spraying system, consisting of a number of small sprays distributed over the first half of the distance which the air-current traverses will have the effect of preventing the formation of dust and moistening the gaseous mixture. The sprays should be placed near the roof, and discharge the water in the directions of the air-current. This arrangement will have an additional beneficial effect in mines generating much firedamp, the descending water spray serving to break up any stratification of gases that may exist in the entries.

The proper quantity of water to be vaporized will depend upon altitude, climatic conditions, and character of the coal. The only danger to be guarded against is the use of an excessive amount of water, which would result in cutting a slate roof; if coal or sand rock prevails, no limit need be established, because, with the lower temperature in the mines in this country, the danger which was pointed out by the British Colliery Commission, that excessive humidity injuriously affects the health of the miner, does not exist, the temperature of the English mines being from 90 degrees to 95 degrees F.

The installation of a spraying device of this character is very inexpensive and there is no cost of operation. A 1-in. supply pipe connected with the pump discharge in the shaft, with branches for some of the entries, is all that is necessary in addition to the spray boxes, which can be purchased at a very low cost (about $2 each). It is estimated that one spray box is sufficient for each 5,000 cu. ft. of air supplied per min. These spray boxes operate automatically as long as the pump is running, unless an independent pressure supply is furnished from a tank or other source. The pressure required to operate the sprays is from 12 to 20 lbs. per sq. in.

I recommend that mining engineers and coal operators, in fields subject to gas explosions, obtain, for their own information, a record for a year, taken once a week, both outside and at the point of upcast, to show the temperature and relative humidity, and from these results compute the amount of water which is carried into and taken out of the mine. It is predicted that the results will be astonishing to a great many.

Another comparison between the conditions in a mine in dry and in wet weather may be made by the operation of internal-combustion engines. The consumption of gasoline in the summer is much greater than in the winter in the same climate; in the warm weather the excess of humidity present in the mixture absorbs a certain amount of heat units before the vapor develops effective power; consequently, an automobile consumes more fuel in the summer than it does in the winter under the same conditions. A gaseous mixture containing dry air becomes explosive with a much smaller percentage of methane, and the higher the ratio of humidity in the mine and the ventilating current the less is the danger.

The following table shows the amount of water in 100,000 cu. ft. of air completely saturated and at various temperatures:

Water in 100,000 Cu. Ft. of Saturated Air.

Degs. F.	Lbs.	Gals.	Degs. F.	Lbs.	Gals.
32	31	3.7	65	97	11.6
35	34	4.1	70	114	13.7
40	41	4.9	75	134	16.1
45	49	5.8	80	156	18.7
50	59	7.1	85	182	21.8
55	70	8.4	90	212	25.4
60	82	9.8			

Example—how much water is contained in an air-current of 80,000 cu. ft., at 45 degrees F., 85 per cent. relative humidity?

(49 lbs. × 80,000 cu. ft.) ÷ (100,000 cu. ft. × 85 per cent.) = 46.1 lbs. per min. (× 1,440) = 66,384 lbs. or 7,960 gals. per 24 hrs.

If this current is warmed to 65 degrees the amount of moisture would represent 61 per cent. relative humidity. Under this latter condition dust will form readily.

SATURATED AIR AS A COOLING AGENT

By Arthur Pennell.

Whenever it is desired to liquefy steam or other condensable vapor, some cooling agent must be employed which has the ability to absorb the heat evolved by such condensation and act as a vehicle for its disposition by some natural means. Cold water, the most obvious agent for the purpose, is often unattainable or too expensive. Air, which is omnipresent in unlimited quantity, also possesses properties which render it an efficient cooling agent.

SOME PROPERTIES OF AIR.

Absolutely dry air does not exist in the lower strata of the atmosphere. It always carries, mechanically mixed with it, more or less water vapor. Air is said to be saturated with water vapor when a cubic foot thereof consists of a cubic foot of water vapor at the elasticity due to the temperature and a cubic foot of dry air whose elasticity is the difference between the barometric pressure and the elasticity of the water vapor. The humidity of such air is 100 per cent. The two mixed form one cubic foot of saturated air at barometric pressure.

Everybody must have witnessed a white fog in a valley on a bright summer morning. The

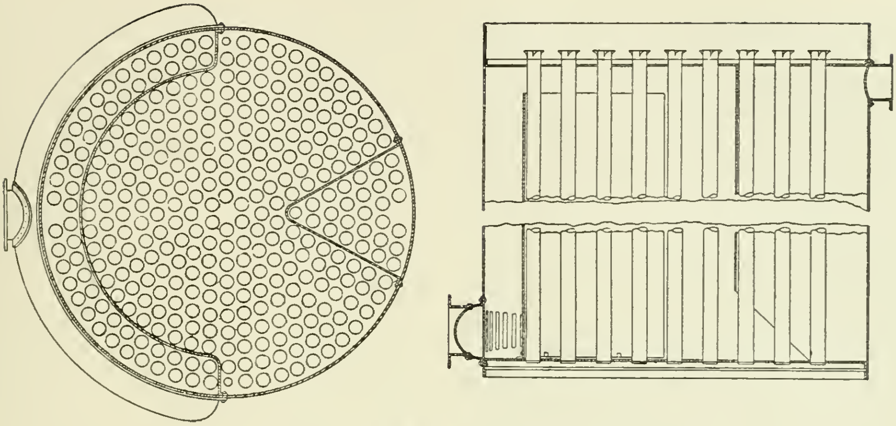


FIG. I.—SURFACE CONDENSER USING AIR AS COOLING AGENT.

air in the fog must have been completely saturated inasmuch as minute vesicles of liquid water were visibly floating therein. As the sun rose higher and higher, the fog gradually dissipated. Sufficient heat had arrived both to vaporize the liquid vesicles and warm the air sufficiently to be able to absorb it. If, at such moment, the shade temperature was 62 degrees Fahrenheit and the barometric pressure 29.92 inches of mercury, each cubic foot of such air would have weighed 0.0761 pound and consisted of a cubic foot of water vapor at an elasticity of 0.556 inch of mercury weighing 0.000881 pound, and a cubic foot of dry air at an elasticity of 29.92—0.556 inches of mercury, weighing 0.0747 pound. Further, each pound of dry air present would have carried 0.01179 pound of water vapor. By noon, we will assume, the shade temperature had risen to 82 degrees Fahrenheit. The air was no longer saturated but carried the same load of water vapor in a state of superheat. If such air had the opportunity of passing over a wet, hot surface, it would absorb water vapor at the ex-

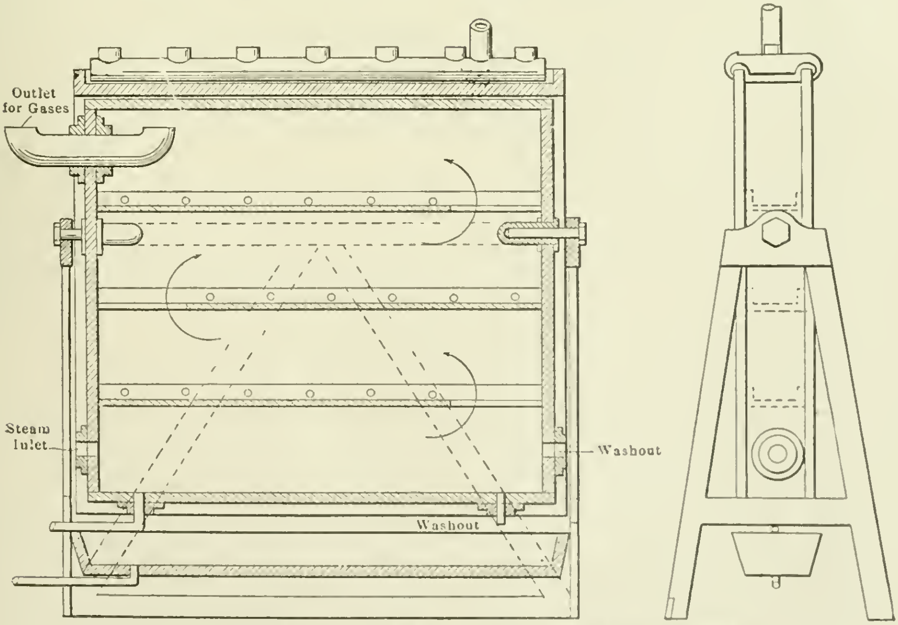


FIG. II.—SINGLE UNIT OF PENNELL FLASK-TYPE STEAM CONDENSER.

pense of the heat of the surface. Should it succeed in saturating itself with such water vapor at 82 degrees, the pound of dry air would be mixed with 0.02361 pound of water vapor and would have absorbed 0.01182 pound of water vapor from the hot, wet surface. A familiar practical example of the foregoing occurs whenever a freshly sprinkled street pavement is drying under a hot breeze.

SOME TEST DATA.

Fig. 1 shows sections of one of a pair of condensers using saturating air as cooling agent, erected on the premises of the Armour Packing Company, of Kansas City. They were designed to condense, at atmospheric pressure, the exhaust steam from a number of simple engines developing a total of about 1100 horsepower. As one of them, while clean, was able to perform the duty, and a compound engine was being installed, the second outfit was equipped to condense the steam from the compound engine. The results of a nine-hour test are given in the next column, this condenser operating upon a York cross-compound refrigerating engine, 30x58x48 inches, running at a speed of 45 revolutions per minute.

Assume water being pumped direct from the Kaw river at a temperature of 75 degrees Fahrenheit, a lift of 40 feet, and the condenser requiring 9.373 pounds of circulating water per pound of steam condensed. Five hundred indicated horse-power (6975 pounds steam) will require 65.376 pounds of circulating water per hour; or, 1,088.75 pounds per minute; lifting 1086 pounds per minute would require 1.32 horsepower; adding 50 per cent. for friction, 1.98 horsepower, which at 15 cents per horsepower for twenty-four hours, would cost 29.7 cents.

The elasticity of vapor at this condenser temperature, 123.7 degrees Fahrenheit, is 3.827 inches of mercury, which deducted from the average barometer reading for this day, 28.58 inches, shows the ideal vacuum would be 24.753 inches; however, this ideal is impossible to obtain by mechanical means. About 21¾ inches should be obtained under best conditions.

It will be noted that the total weight of steam, condensed at a temperature of 123.7 degrees Fahrenheit, was 71,550 pounds. The condensation was effected by the atmospheric vaporization of 499 cubic feet, or 31,150 pounds, of water. The weight of water atmospherically vaporized was only 43.5 per cent. of the weight of the steam condensed. This result will be corroborated by the result of another test made elsewhere, several years later, on another type of condenser.

Average steam pressure at engine, gage, lb	139.8
Average vacuum per engine, gage in	18.38
Average temperature in condenser, deg. F	123.7
Average temperature of circulating water, deg. F	116.4
Average temperature of city water, deg. F	52
Average temperature of outside air, deg, F	62
Average temperature of saturated air of condenser, deg. F	106
Average draft in stack of condenser, in.	0.1
Average humidity of outside air, per cent	67
Total amount of steam condensed, lb	71,550
Average amount of steam condensed per minute, lb	132.5
Total amount of circulating water used, 16,700 cu.ft., or lb	1,032,060
Average amount used per minute, 233.17 gal., or lb	1911.22
Total amount of city water used, 499 cu.ft., or lb	31,150
Average amount used per minute 6.93 gal., or lb	57.7
Ratio of circulating water and steam condensed	1 to 14.42
Ratio of city water and steam condensed	1 to 0.435
Average horse power per hour on engine during trial, per indicator cards	569.74
Average weight of steam used, per I.H.P	13.95
Average horsepower required to run air pumps	10½
Average horsepower required to run circulating pump	3
Total amount of condensing surface, sq.ft	3900
Amount of steam condensed per sq.ft. surface, per hour, lb	2.038
Cost of city water for 9 hours, 3740 gal., at 2½ per M	9.25c
Cost of circulating condensing water for 9 hours (233.17 gal. per min.), 3 horsepower per hour, at 15c. per horsepower—24 hours, c	15.625
Total cost for 9 hours, for 569.74 horsepower, c	24.875
Cost of water for 500 indicated horsepower, for 24 hours, under existing conditions, c	58.2

RESULTS OF NINE-HOUR TEST.

The amount of steam condensed per square foot of surface per hour was 2.038 pounds, when the condensing temperature was 123.7 degrees, while the initial and final temperature of the circulating water was 116.4 degrees. This figures out 287.1 B.t.u. transmitted per square foot of surface per hour for 1 degree of difference. The surface was somewhat coated with scale. The draft, due to 50 feet of flue was 0.1 inch of water. Manifestly, to obtain the low condensing temperature necessary for high vacua, artificial draft, capable of supplying three times the volume of air, would have to be installed.

A new field is now being opened for a suitable modification of this type of condenser in oil refineries, for condensing petroleum vapor. As these vapors arrive at temperatures ranging from below 100 degrees Fahrenheit to over 600 degrees, the facility of controlling the cooling agent is of considerable economic value.

Fig. 2 represents a flask type of condenser for steam at atmospheric pressure for use in ice plants. The steam enters near the bottom, follows the course indicated, condensing as it goes toward the outlet at the far end of the top bay, when the noncondensable gases escape into the air. The condensation water is led away from an outlet in the bottom. The circulating water is caused to flow in a thin sheet over the surface, thoroughly wetting it down, to be received in a collecting trough and thence into a catch can, from which the circulating pump returns it to the distributing system on the top.

Conditions were such that only 10-minute tests were practicable, the results of one of which is appended:

Time, Min.	Surface, Sq. Ft.	Condensed Water Entering Hot Well, Gal.	Decrease in Connecting, Can, Gal.	Temp. Circulating Water, Deg. F.	Temp. Issuing Gases, Deg. F.
10	24	6	3	183	150

It will be noted that the circulating water reached a temperature of 183 degrees, or 19 degrees below that of the condensing steam inside. In this case, the surface was new and absolutely clean. Calculation shows that 416.4 B.t.u. were transmitted per hour per square foot for each degree of difference. Further, the amount of water required to "make good" will be noted. The atmospheric vaporization was 50 per cent. of the amount of condensation water delivered. In this case the steam came direct from the boiler and was probably more nearly dry than in the other test. The amount of "make good" water varies with the weather conditions, probably ranging from 33 per cent. in zero weather to 66 per cent. in hot, dry summer weather.—*Power and the Engineer.*

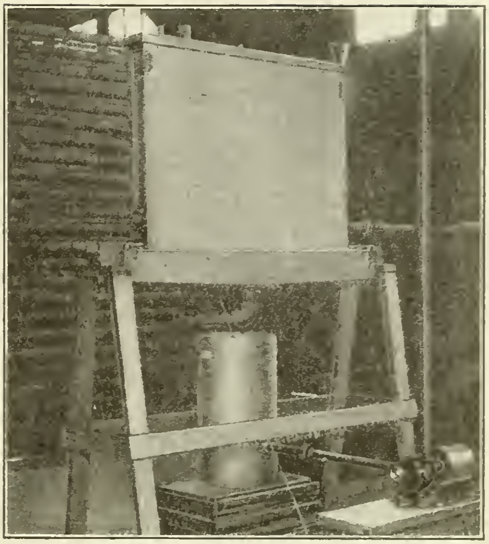


FIG. III.—AN ICE-PLANT INSTALLATION OF THE PENNELL CONDENSER.

HOMEMADE DESPATCH TUBES

When the inspectors have completed their examination at the inspection pit each man writes his report on the proper form and sends it by pneumatic despatch tube to the engine house office. By this means the reports covering the condition of the engine will reach the work distributor's desk almost as soon as the engine reaches the ash pit. The tube can easily be installed by any competent pipe fitter and is usually constructed of two-inch pipe laid in a box underground or carried on the ends of the ties. The fins should be smoothed off the inside of the pipe and a simple carrier can be made of an old air brake hose. When the reports are ready they are slipped into the carrier and the latter pushed into the open end of the tube. A hinged flap valve is then held against the tube and the air pressure turned on, a distance of several hundred feet requiring only a few seconds. As almost all of the larger engine houses are provided with air compressors, it is easy to secure the motive power needed by using a reducing valve set to a few pounds. The carriers as they come out of the tube strike against a spring buffer a foot or so away and drop into a basket. The man at the receiving end then signals to the other end by means of a bell or incandescent lamp and the air is shut off and the flap valve allowed to fall.

The usefulness and value of this simple and inexpensive tube system can hardly be appreciated by those who never used it. The condition of an engine is known to the engine house force within a few minutes after it reaches the inspection pit, and they know at once whether the engine can be marked up for a run and a crew called or whether it will require shop attention which may take several hours. The connection of inspection pits and pneumatic tubes will save their cost many times over at nine-tenths of the large engine terminals of the country.—*Pittsburg Railroad Club.*

FLOATING A HEAVY CAISSON

The Caisson for one of the piers of a bridge built some years ago across the Kaw river at Kansas City, Mo., was found to be too heavy to float in the shallow water near the shore if left in proper condition for sinkinng before being launched. The caisson was 22 ft. wide and 56 ft. long and the distance from the cutting edge to the top of the roof of the working chamber was 13½ ft. It contained about 10,000 cu. ft. of timber and about 20,000 lb. of metal in the shafts, cutting edge and bolts. With this weight the cutting edge was submerged between 10 and 11 ft., which was more than the depth of water near shore. A false floor of the usual construction was built in the working chamber beneath the lower row of horizontal struts, which were 1 ft. 10 in. above the cutting edge. Two-inch plank was used, and after the floor was finished the joints were carefully calked to exclude water from the working chamber. The caisson was then floated to place, the false floor removed and the caisson allowed to settle to the river bed.—*Engineering Record.*

[Compressed air at a pressure not exceeding 5 or 6 lbs. would have expelled all the air inside the caisson, and it would then have floated higher than with the false floor. In either case precautions would have been required to keep the caisson level.—Ed. C. A.]

Timber in a flooded mine, even after 20 years or more, will be found intact and temporarily unimpaired, but after exposure to the air it is speedily affected by decay.

AIR COMPRESSION UNDER DIFFICULTIES

The indicator cards here reproduced from *Power and The Engineer* will be found interesting. Figs. 1 and 2 are from a two-stage air compressor with air cylinders 28 and 17 inches respectively, and cross-compound Corliss steam cylinders 16 and 30 inch by 36 inch stroke. These cards were taken from the air cylinders when said to be operating under normal conditions. The cards are smaller than actual size, so that the scales must be disregarded.

Fig. 1, from the low pressure cylinder, suggests the remark that the intake line is unusually low. Although the clearance at the delivery end of the cylinder is not large the apparent total loss of cylinder capacity is about 14 per cent., and chiefly on account of the length of piston travel before the intake pressure rises to the atmosphere line. Some compressors show no loss at this end of the stroke, filling the cylinder right up to the atmospheric pressure before the compression stroke begins. In the cards as here shown the low pressure cylinder was compressing to 25 or 26 lbs., and the second cylinder was delivering the air at about 100 lbs.

The principal interest is in Fig. 3. Recently an accident to the low pressure steam element of the compressor put all that side, both steam and air, out of business for a time. As it was impossible to get along without air for any length of time, and still keep all parts of the plant in operation, the master mechanic decided to run the compressor on the high pressure side alone. What was done is described by Mr. Cederblom, Gary, Ind., as follows:

"The low-pressure connecting rod was taken off, both steam and exhaust valves taken out and the bonnets replaced; also, the positive-motion air-inlet valves and several of the poppet type of discharge valves on the first stage were taken out. This change allowed free exhaust of steam through the low-pressure steam cylinder, an air inlet, unrestricted as possible, through the low-pressure air cylinder, and an intercooler into the high-pressure cylinder.

"When the compressor was started again it took over an hour's running at full speed to get the line pressure up to 80 pounds; whereas, with both sides "hooked up" we could always get the required 100 pounds in 10 minutes. It soon became evident that unless the demand for air was lessened, the pressure could not be raised above 80 pounds, which was about 25 pounds too low to operate some of the pumps and hoists.

"Afte speculating on the interesting question of how much air the compressor was turning out in its one-sided condition, we decided that the trouble lay in the intake resistance to the air, due to taking it at atmospheric pressure (only about 12.5 pounds here) through passages and inlet poppet valves designed for air at 25 pounds.

"The master mechanic then decided to get the required line pressure by running a 1-inch bleeder to the third stage of the four-stage high-pressure compressor alongside. The pressures of the different stages were 25, 115, 350 and 1000 pounds, and although the second stage would have suited the purpose better, the bleeder was connected to the third stage for reasons of despatch and convenience. A valve was placed in the bleeder to throttle the pressure and, the other end being connected to the discharge line of the crippled compressor, we soon had air enough for the demand. A couple of hours later when the quantity required was greatly reduced, the compressor was able to hold 105 pounds with the bleeder valve closed, and then, wishing to see exactly what was doing in that hard-working air cylinder, I put on the indicator and got the diagrams shown in Fig. 3.

"As expected, the admission line proved to be almost 7 pounds below atmospheric pressure, as compared with 1.5 pounds on the diagrams shown in Fig. 1. The diagrams also show that the piston actually traveled about one-fourth of the return stroke before getting the pressure back to the intake pressure, as shown at *A*, Fig. 3; and about two-thirds of the stroke before reaching 25 pounds, as shown at *B*, which would be the regular intake pressure under ordinary conditions. By comparing the volumes *V* discharged per stroke, Figs. 2 and 3, it can be readily seen how the capacity was reduced.

"Another interesting point is in comparing the compression curves under the different conditions. By plotting out the isothermal curve on Fig. 3, it will be seen that the actual curve gets much nearer to an adiabatic-compression curve than on Fig. 2, thus raising the mean effective pressure and hence the power required per unit of free air.

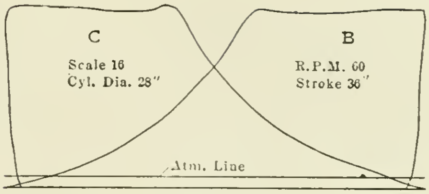


FIG. 1

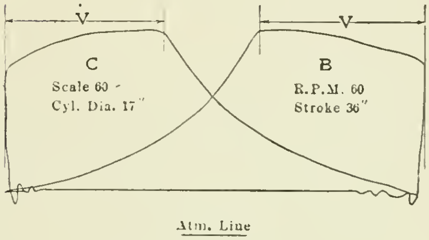


FIG. 2

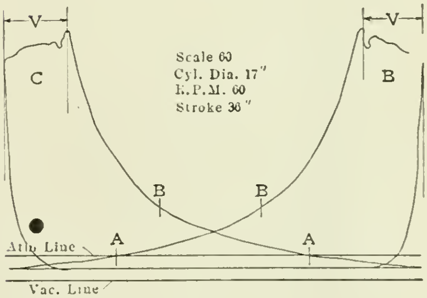


FIG. 3

"While Fig. 3 represents an extreme case, it goes to show that too much attention cannot be given to air intakes and inlet valves. For example, in making new valve springs to replace broken ones, it is quite possible to make them much stronger than the old ones; or, in the case of positive-motion inlet valves, the point of admission might easily be too late, due to a slipped eccentric, lost motion in reach rods, etc., all of which would necessitate a greater degree of vacuum at the time of admission, and thus throw unnecessary work upon the compressor.

"A case in point is that of an engineer who extended his intake pipe a few hundred feet out into a bush, to get the screen away from the road dust; and the first fall afterward the screen became clogged with leaves to such an extent that it took a 17-inch vacuum to get anywhere near enough air for the demand.

"I have noticed that there seems to be very little practical information on air compression in the bulk of engineers' journals, and if more attention were given to this important branch of our work, I am sure it would prove most acceptable to a large number of us who have compressors included in their plant. More light could easily be shed upon some phases of the work. For instance, I read not long ago the statement of an engineer to the effect that the only function of a receiver on an air line was the same as that of an air chamber on the discharge of a pump. I have always thought two of the most important reasons for a receiver being installed was to provide a place in which to *cool* the air, thus separating most of the contained moisture and allowing it to be drawn off; also, to provide a storage place, thus tending to prevent sudden reductions of pressure."

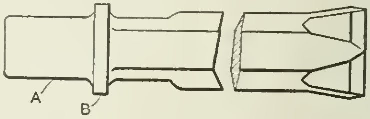
[The most unaccountable detail of the above narrative is that they took out only "several" of the discharge valves where the intake air was temporarily to pass, instead of taking out every one of them. This "several" may partially account for the very low intake line in Fig. 3.—Ed. C. A.]

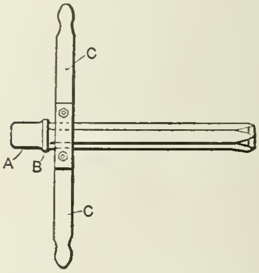
PNEUMATIC WALNUT HARVESTING

The growing of English walnuts is now one of the established and profitable industries of California. One of the chief expenses involved hitherto has been the cost of gathering. A large portion of this expense is now done away with by the pneumatic walnut picker, the invention of an actual walnut grower, Mr. L. L. Sidwell, Pico Station, near Los Angeles. This walnut picker is mounted on a truck propelled through the orchards by a gasolene engine, the same engine driving the suction fan, the operation of nut gathering being similar to that of the now familiar vacuum cleaner. The nuts are not picked from the trees but gathered from the ground. The exhausting ducts have fan shaped mouths near the ground which lead to a large drum on the truck. These ducts spreading in front of the truck 8 or 10 feet wide suck up everything loose which comes in their way and convey it to the drum. Here the clods, twigs and rotten nuts are separated from the perfect nuts, the latter being poured into sacks. One man looks after all of the gathering and bagging operation and another man does the driving and steering. The first year's use of the machine shows a substantial reduction in the cost of nut harvesting.

INTERESTING USES OF THE PNEUMATIC RIVETING HAMMER

The writer had occasion to set a bed-plate on an old concrete foundation and the thought of drilling eight 2½-inch anchor bolt holes about 3 feet deep, by the old-fashioned method of sledge-hammer and stone drill, set his mind to work. The outcome was the making of a stone drill such as shown in the accompanying engraving. The shank *A* was turned to suit a pneumatic riveting hammer, and hardened. Two handles *C* were also provided and bolted under the collar *B*, as shown. It required two men to operate the drill, one to run the hammer while the other two turned the drill back and forth about a quarter of a turn. The result was that the holes were drilled in less than three hours, which is only a fraction of the time usually required for the same work by the old method.

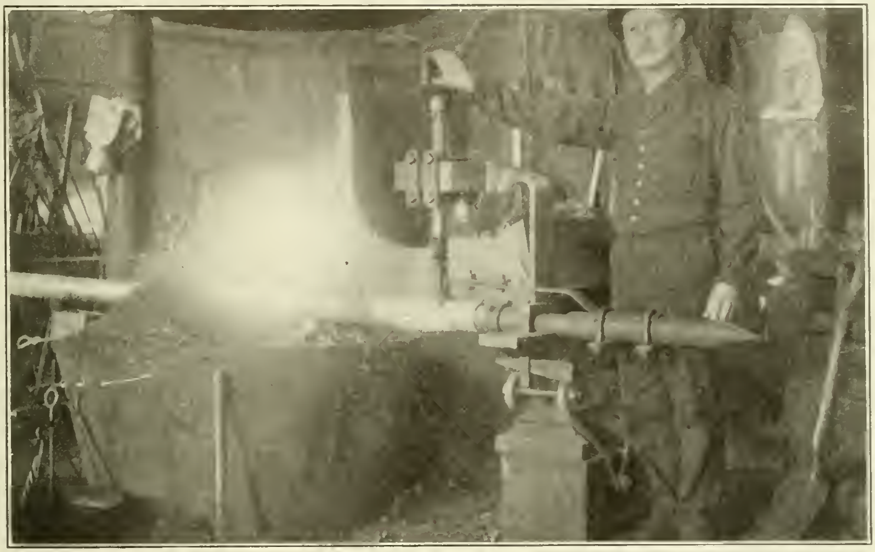




Another interesting use of the pneumatic riveting hammer, is to drive out fitted bolts that have become tight by rust or other causes. The instance in this line to which the writer refers was the removal of connecting-rod strap bolts on a small locomotive. These bolts were driven in from the top, and when it was necessary to take them out it was impossible to move them, and as a fair blow could not be given with a sledge, this method was abandoned. A 10-ton hydraulic jack was then tried, and while it would lift one side of the engine, the bolts would not stir. The pneumatic hammer with the ordinary button-set in it was next applied, and the result was that the bolts were removed in less than a minute each.—*Machinery.*

WELDING BOILER TUBES WITH A PNEUMATIC HAMMER

The half-tone herewith, which, by the way, is from an amateur's postal card photo, tells very clearly and completely how a pneumatic hammer or riveter is used in welding 3 in. boiler tubes in the blacksmith shop of the Homestake Mine, South Dakota. In the welding of boiler tubes all depends on the rapidity of the blows as the metal cools so quickly, and where hand hammering is employed it has been the practice to heat the mandrel to nearly a white heat, but with the pneumatic hammer used as here shown this precaution is not necessary.



WELDING BOILER TUBES WITH PNEUMATIC HAMMER.

The apparatus here shown is, of course, homemade except that a standard pneumatic riveter is used. As will be seen, the mandrel, upon which the tube to be welded slips easily, is clamped upon the anvil exactly in line with the tube as it lies in the fire. The swage is held by a flat spring, clamped to the rear of mandrel, just high enough to clear the tubes. The hammer is held in exact position by a standard which is clamped to the side of the anvil. When the tube is at just the right welding heat it is shoved forward onto the mandrel, the operator manipulating the hammer valve to shower the blows upon the swage while a man at the other end keeps the tube turning.

"COAL DUST AND MINE EXPLOSIONS"

In our issue for January at page 5147 appeared an article with the above title by Mr. Wm. N. Page, President of the West Virginia Mining Association. This was an open letter to the West Virginia Mine Managers, and it first appeared in the columns of *Coal*. The positions and conclusions of Mr. Page are, it will be seen, quite vigorously controverted in the following letter, which also was printed in *Coal*. The writer says:

Major Page starts out with the affirmation that "Dust as dust is not explosive." It would be waste of time to adduce proofs to disprove such a statement; one might just as well say that powder as powder is not explosive, gun cotton as gun cotton is not explosive, and so on ad infinitum. Coal dust does explode. He says a chemical alteration is essential to an explosion. Is it not true that chemical alterations, re-actions and combinations, are essential to all explosions of any nature?

Let us stop discussing the obvious, and acknowledge the fact that coal dust is not only an explosive, but the most deadly and dangerous known in our mines. What does it matter whether it is caused like an explosion of flour-dust, by an infinitely rapid combustion, or by as equally rapid distillation of explosive gases? The result is the same.

I agree with the writer that currents of high velocities are dangerous because of the large amounts of dust they carry in suspension; but the danger can be very much reduced by proper splitting of the current, thus reducing the velocity and volume. We must not lose sight of the fact that explosions do not originate in high-velocity currents; they simply serve as a medium to exaggerate the explosion, the primal explosion occurs at the face.

The trouble with most writers and investigators along this line is that they get away from the vitally important point, viz.: the origin of the explosion, which, in forty-nine cases out of fifty, is in the face where the air current is so feeble that it will scarcely move the vanes of the anemometer. Often the miner has a hole drilled, loaded and tamped before the machine-runner has finished cutting his place; as soon as the machine is moved out, with all the cuttings unremoved and before the dust has had time to settle, the shot is fired. Should it be a blown-out shot, and an explosion of dust occur, it is likely to be projected into the entry and the explosion become general, limited by the amount of dust held in suspension or by the amount of oxygen. Is it not plain to every sensible miner that the face of the rooms and entries is where the greatest precautions should be taken? If explosions are prevented there, there is little danger of explosions in the entries unless gas is allowed to back into them from old workings, which would be culpable neglect and criminal carelessness.

Explosions are nearly always caused by blown-out shots and consequent ignition of coal-dust, fire-damp or a mixture of both. The rigid observance of a few simple rules would reduce explosions to the vanishing point so far as the face is concerned. Before blasting, load out all machine cuttings, thoroughly spray the roof, sides and floor of the place to be blasted thirty or forty feet back from the face; let all shots be fired by experienced men, whose duty it shall be to see that the above is carried out, that the hole is properly drilled and that the place is free from fire damp. Do this, and explosions will seldom occur.

I am a thorough believer in the tendency of humid atmospheric conditions to lessen the danger of coal-dust explosions; the frequency of dust explosions when atmospheric conditions are the reverse of humid is to me a very convincing proof. For six, seven or eight months in the year humid atmospheric conditions prevail. It is proposed to bring about these conditions by artificial means in periods when they do not obtain naturally; but if this would increase the death rate to such a fearful extent, as Major Page asserts, it would be better to extract artificially the moisture from the air during the warm months before it enters the mines, allowing it to enter perfectly dry and suck up the natural moisture of the mine.

Some startling statements regarding the effect that water held in suspension has on the roof are made in this letter. While I do not for an instant dispute that currents of high velocities, surcharged by moisture, have a deteriorating effect on slate or soapstone roof, I do deny the statement that it plays any important part in accidents caused by falls of coal and slate, and will prove it to the satisfaction of every unbiased man acquainted with coal mining. Here are a few extracts from the letter I would ask the reader to go over in full:

"Water will not only affect the health of the miner, but it is the indirect cause of every death from roof falls."

"Sixty-six per cent. of all underground fatalities are attributable to falls of roof and coal, and only 34 per cent. to all other causes." He assumes that five per cent. of the deaths are due to coal-dust explosions. "It would seem, therefore, that the water remedy proposed in efforts to save five lives is now the death portion of 66, and any increase of water in the mines must necessarily add to roof fatalities." He then goes on to state that in West Virginia 90 per cent. of the roof is composed of slate or fire-clay, and that these substances disintegrate very rapidly when exposed to the atmosphere, and the more water introduced either by sprinkling or saturation of the air the more deadly will be the consequences.

Quoting again from the letter, he says, "We had a single phase danger with fire-damp, a two-phase danger with dust, and we will have a three-phase danger with water more deadly than the other phases combined." That these statements have no foundation in fact, the following will prove. For at least seven months in the year the general atmospheric conditions are humid, and nature in this way sends bountiful supplies of water into the mines. I ask: does death exact a greater toll by falls of roof during the humid months than in the dry months? Not that anyone has ever noticed, and the reason is plain; it is because 95 per cent. of all injuries and deaths by falls of coal and roof take place immediately in the face, where there is no current, where neither the roof nor the coal has been exposed to the atmosphere, where humid or dry atmosphere has no more to do with falls of roof than I had to do with building the walls of Babylon.

It is the roofs of the entries which are exposed to the deteriorating effects of high velocity currents, especially the main entries. How seldom do we hear of a man being hurt or killed by a fall of rock in an entry? The secret of that is because the mine management is responsible for the safety of the men in the entries, and where poor roof conditions prevail they are subject to rigid daily inspections and all loose rock taken down or properly timbered. If the mine management were equally responsible for the safety of men in the face, there would soon be an appreciable diminution of accidents there. It is looked upon as a disgrace to have men injured by falls of roof in an entry; every mine manager knows that. I venture the assertion that more men were killed by explosions last year in the States of Pennsylvania and West Virginia than have been killed by falls of roof in the entries of all the mines in both States in 50 years. I assert, again, the trouble and the slaughter is at the face, where water held in suspension plays absolutely no part in it. Here the chief factors are carelessness and ignorance.

Believing then, as I do, with so many eminent mining men in the efficacy of humid atmospheric conditions for the prevention of dust explosions, I would urge upon mine managers everywhere to adopt measures to bring about these conditions when they are not naturally present. Humidity does not affect the health of men in low temperatures; in such temperatures as prevail in our mines no deleterious effects have ever been noticed from the cause.

Major Page says, in his closing paragraph: "In our efforts to protect life and property we must look to the falling leaves as well as to the burning bush, and the men who die, one by one, under roof falls are as much entitled to protection as those who lose their lives in spectacular disaster." I thoroughly agree that we ought to protect the men as much as possible from falling roof; but by affording them a protection which is no protection, inasmuch as it has nothing to do with the falling roof where it kills, we are in grave danger of bringing about more of those tragic, spectacular disasters; which, God forbid!

So far as Major Page's letter is concerned, nothing is suggested to prevent these falling leaves. In my opinion, deaths and injuries can be reduced very materially by dividing the mines into sections of suitable size and appointing experienced men to each section, whose sole duty it shall be to look after the safety of the men; the section to be of such size that he can visit each working place twice each day; see that each place is properly timbered, and, if not, to stay there until the necessary timbering is done, and assist and instruct the men in every way. In a word, to make him responsible for the safety of the men under his charge. In the north of England, where I worked in the mines for many years, this system is in force at all the collieries, and accidents from falling roof or coal are very infrequent.

If they find it necessary to do this in England, where the men are all skilled miners and of comparatively high intelligence, all speaking a common language, how much more do we need a similar system here, where most of the miners are inexperienced, unskilled, ignorant, and mostly speak in an uncommon tongue?

Yours truly,

J. L. Dixon, E. M.

Pittsburgh, Pa.

EDISON'S WAY

The following is from a "talk" by W. S. Andrews before the Schenectady Section of the A. I. E. E.:

Word came to Edison in New York that the Cumberland people where burning out armatures rapidly. I made my appearance at the station in the evening and was met by a colored man, the engineer. I asked him if he were the only attendant, and if he attended the boilers, engines, machines, etc. He said "Yes, sah; I'm a hustler!" I asked him if he had been burning out armatures lately, and told him that I had come from New York to give him advice. I then asked him how he knew when the dynamos were carrying too much current. He said that some one had told him that when the wires were carrying too much electricity they would get hot. He therefore felt of the wires occasionally, and if he found one getting hotter than the others, he would put in a little more resistance and cool it down. As far as I know, this is the first record we have of a "hot wire" ammeter.

I went back and reported to Edison. Edison said, "We have got to get up an ammeter." We set to work and made some in about a week or so. We got up the old Edison pendulum ammeter, and the first sample of this device was shown to Edison at the machine works. He said it was pretty good, but that we needed something rough. "Have six made up. When you examine and test them in the testing room, have them packed and then call me. I do not care to see them until packed and ready for shipment." When this was done, he was notified and came in. Edison said, "Put them on the table. Now, then, get up on the table and kick em'off; if they won't stand this, they will never reach Cumberland in operating condition." They were kicked off the table as hard as the fellow could kick them, and sent spinning over the floor. Edison then said: "Now I will look at them." Then after a careful examination, they were approved for shipment. It is needless to say there were no jewel bearings in the instruments at that time.

PRESERVING EGGS

An interesting method of preserving eggs by means of desiccation was lately put into successful operation at Sydney, New South Wales. Eggs freed from their shells are dried at the relatively low temperature of 130 deg. Fahr., in containers kept constantly at this temperature and from which the air has been exhausted. When thoroughly dried and reduced to a coarse powder the egg material can be preserved for an indefinite period in ordinary packages, if kept in a dry place. The eggs are "reconstituted" by the simple addition of water to the dry powder, the resultant mass being quite indistinguishable from newly beaten-up eggs. There is no alteration in the chemical composition, and purity, ease of digestion flavor, etc., are said to be unaffected by the operations.

COMPRESSED AIR PIPE CAPACITIES AND VELOCITIES

The following table we reproduce from a paper by Mr. E. J. Laschinger before the Transvall Institution of Mining Engineers. As it is generally understood that velocity of 20 feet per second in the mains, is preferable to anything higher, it will be seen that these figures begin near where it would be better to end. They, however, are probably closely applicable to current South African practice.

		SURFACE MAINS.		SHAFT MAINS.		DISTRIBUTING PIPES.	
Nominal Size of Pipe.	Actual Internal Dia. Inches.	No. of Drills.	Mean Velocity Ft. Sec.	No. of Drills.	Mean Velocity. Ft. Sec.	No. of Drills.	Mean Velocity. Ft. Sec.
1	1.05	.46	19.1	.51	21.1	.64	26.6
1¼	1.38	.85	20.5	.94	22.6	1.18	28.4
1½	1.61	1.21	21.3	1.33	23.5	1.67	29.6
2	2.07	2.12	22.7	2.34	25.0	2.94	31.5
2½	2.47	3.16	23.7	3.48	26.1	4.37	32.9
3	3.07	5.15	25.0	5.17	27.6	7.14	34.7
3½	3.55	7.15	26.0	7.86	28.6	9.91	36.0
4	4.03	9.5	26.8	10.5	29.5	13.2	37.2
4½	4.51	12.2	27.5	13.5	30.3	17.0	38.2
5	5.05	15.8	28.4	17.4	31.2	21.9	39.4
6	6.07	23.8	29.7	26.3	32.7	33.1	41.1
7	7.02	33.1	30.8	36.5	33.9	45.9	42.7
8	7.98	44.2	31.8	48.6	35.0	61.3	44.1
9	8.94	57.1	32.7	62.8	36.1	79.2	45.3
10	10.02	73.8	33.7	81.	37.1	102.	46.7
12	12.	111.	35.2	122.	38.8		
14	14.	157.	36.6	172.	40.3		
15	15.	183.	37.2	201.	41.0		
16	16.	212.	37.8	233.	41.0		
18	18.	276.	39.0	303.	42.9		
20	20.	349.	40.0	385.	44.0		

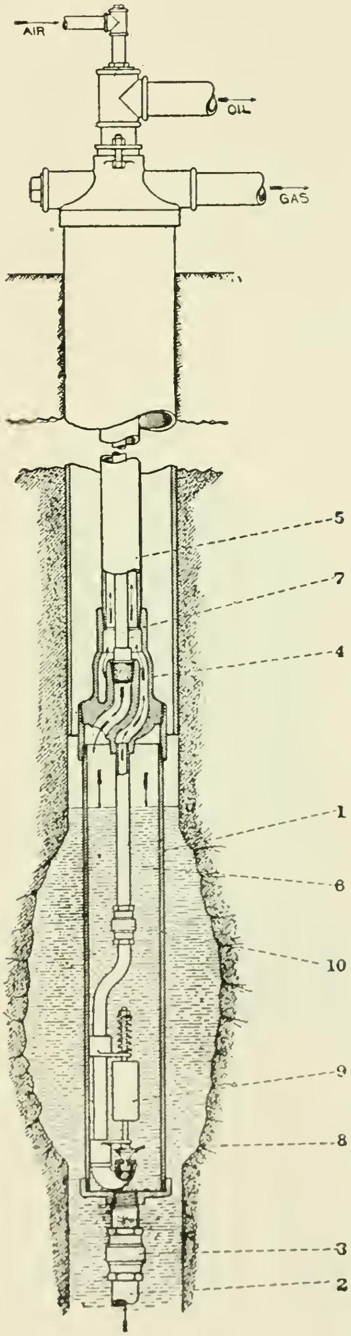
FLOWING OIL WELLS BY COMPRESSED AIR

Compressed air is being used very successfully in the flowing of oil wells on the farm of Mr. John W. Waitz near Oil City, Pa. One hundred wells are thus equipped and they yield a daily average of 200 barrels. The average depth of the wells is 800 feet, and the air pressure required is somewhat more than 400 pounds per square inch. The equipment of the wells will be readily understood by a reference to the accompanying engraving.

An oil receiver 1 is located in close proximity to the bottom of the well, presumably in the "shot hole," in the oil-producing stratum; into this receiver oil flows by gravity through the inlet pipe 2, which is provided with a check valve 3. The receiver is attached at its upper end to the by-pass 4, which in turn is attached to the tubing 5. An oil-delivery pipe 6 extends from the by-pass down into close proximity to the bottom of the oil receiver. An air-inlet 7, which is provided upon its lower end with a suitable packer, seats firmly in the upper end of the by-pass. The receiver 1 is composed preferably of 4¼-inch casing, and varies in length from 60 to 200 feet, depending upon the capacity or production of the well.

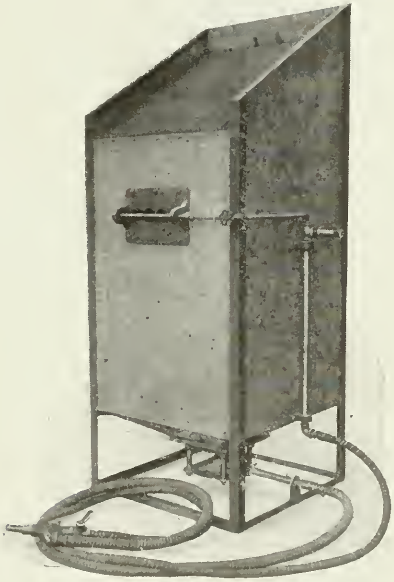
When the well is to be flowed, air is admitted to the upper portion of the receiver and, acting upon the surface of the oil, forces it downward into and through the delivery pipe 6, into the tubing 5, thence to the surface into a receiving tank or any suitable receptacle. Pipe 6 is provided at its lower end with an automatic valve. To the stem of disk 8 of this valve is attached a float 9, the weight of which is nearly balanced by a spring; when the float is submerged in fluid it is buoyed up and the valve-disk is held up from its seat. When the oil is forced from the receiver, the float lowers and causes the disk to seat, thus preventing the entry of air into pipe 6. A check valve 10 prevents the return of oil from the pipe 6, or tubing 5, into the receiver, so that said pipe and tubing always stand full of oil. The number of times that wells are flowed daily, depends upon the amount of oil they produce.

One of the valuable features is the "compounding" of the air. This operation consists in utilizing the air more than once. The air is turned into well No. 1, and when this well ceases to flow, a pressure gage upon the air



COMPRESSED AIR IN OIL WELL.

pipe leading to it will show a pressure of say 400 pounds. Communication is now closed between the air pipe of well No. 1 and the air compressor or air receiver, and the air pipe leading to well No. 2 is placed in communication with the air pipe leading to well No. 1; the air now flows from well No. 1 to well No. 2 until the air pressure in the two wells equalizes, and when the pressure gages show such equalization of pressure, communication between the air-pipes of the two wells is closed and the remaining air in well No. 1—which is at 200 pounds pressure—is taken back into the air compressor. Receiver or full pressure is then turned into well No. 2 and it is flowed in the same manner as No. 1.—*Scientific American.*



NOVEL SAND BLAST OUTFIT

The half-tone shows a sand blast outfit brought out by The Curtis & Co. Mfg. Co., St. Louis, which shows a radical departure in design and operation. The sand reservoir or tank is open at the top, but is covered with a screen of such mesh as to allow the dust and sand not too large to fall through, while pieces of castings or other foreign material roll down the incline and are rejected. Before the sand has a chance to drop into the tank the dust is separated from it by means of a small air jet, so that only sand itself and of the right size enters the hopper. In the conical bottom of the tank is an opening, about hand-hole size, and under this is a plate suspended by four studs. The sand drops freely through the hole onto the plate, forming a conical pile which as it increases stops the hole and prevents overflow. The sand hose and the air hose are separate, so that the sand is not in contact with the air under pressure, and if the air carries moisture the sand is not dampened or clogged by it. The blast of air through the nozzle creates a partial vacuum in the sand hose, and the sand is thus drawn by suction from the pile under the tank, the supply of sand being kept up automatically. The operator has only to control the air, which is done by a handy valve right at the nozzle. The machine can be filled without stopping or interfering with the sand blasting operation. If the sand hose becomes choked it can be cleaned at once by pressing the nozzle against the floor for a few seconds; only a cheap grade of hose is required for the sand hose. The air hose must of course be strong enough for the pressure.

LIQUID AIR IN THE MINE

The following is from the report of a lecture by W. W. Tunnicliffe at Ashby-de-la Zonche, Eng., on the Chemistry of Mine Gases:

The lecturer commenced with a most interesting exposition of liquid air. Amongst other experiments dry felt was saturated with liquid air, but when touched with a flame violent combustion was caused. Similar effects were produced with a roll of cloth, bound with wire and suspended for a time in the liquid. The explosive violence with which it burns, said Mr. Tunnicliffe, suggest the use of liquid air in blasting operations. He mentioned that liquid oxygen is now easily produced, and will probably be in use in the rescue apparatus of the future. Under ordinary circumstances half-a-pint of oxygen was needed every minute by a man, but under excessive work the need rose to nearly three pints per minute. In most of the rescue apparatus the oxygen supply was limited to three hours, but a pint of liquid oxygen would yield 800 pints of the gas at ordinary pressure, and would, therefore, last very much longer.

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L. I. WIGHTMAN, - - - Business Manager
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NAVARRO

One cannot run over the briefest sketch of the life of José F. de Navarro, who died at his home in New York on Feb. 3rd, eighty-six years old, without realizing that he was an exceptional man, a man of initiative and of large achievement, who successfully inaugurated or established a number of the large world-moving enterprises of modern times. These several undertakings of his were quite unrelated and showed a vast reach of interest and ability. We must believe, however, that his most far reaching and enduring work was in the aid and push he gave to the development of the rock drill.

Mr. Navarro in 1904 prepared for private circulation a brief record, scarcely an autobiography, of his varied career. He was born in Barcelona, Spain, of one of the grandee families, his father dying in his infancy. He never became an American citizen. He graduated as a mid-shipman at the Spanish Royal Naval Academy when fifteen years old, and then went to live with his uncle at Havana, Cuba. His uncle had a large machine works and foundry, and here in the next year or so the young man gained considerable knowledge of shop operations. Serious disagreements caused a separation, and young Navarro then went to Philadelphia where he had discouraging experiences, acting among other things as an instructor in a Jesuit college for two or three years, during which time he privately studied the text books of the Rensselaer Polytechnic Institute of Troy, N. Y. Returning to Cuba he bought land on credit which he sold at a good profit and also realized $5,000 on a patent for a spark arrester. He enumerates in his life work eight business enterprises, the first being founded on his twenty-first birthday, and three of them being commercial in character, although in connection with the third he was engaged in the manufacture of water meters for the city of New York. "With the experience acquired in manufacturing the water meter," he says, "Sergeant and Cullingworth, my two capable and honest foremen and myself formed a company for jobbing purposes in the machinery line." This brought things in good shape for his fourth business enterprise. "We succeeded in picking up the whole of the capital stock of the Ingersoll Rock Drill Company, a broken down concern. After perfecting their defective machines, we made an immense success." The embarrassments entailed by a later enterprise compelled Mr. Navarro to sell out, but he received a check for $540,000 for the stock originally valued at $45,000. The fifth Navarro enterprise was the Metropolitan Elevated Railway of New York. Of this he says: "I was certainly the initiator of the great work, the prime mover, the engineer minus the parchment." The sixth enterprise was the building of the Navarro apartment houses, Central Park South, which cost $6,000,000. This was a "tragic experience," and a financial failure, but the buildings were suggestive and provocative of a vast succession of edifices whose builders have profited immensely by the lessons afforded. The seventh enterprise was the manufacture of cement upon a large scale, and the last had to do with a coal pulverizing stoker. Mr. Navarro's summing up of his career is highly suggestive. He says:

"Thus I have worked for the last sixty-six years, ending moderately successful, but not in proportion to my efforts and the magnitude and possibilities of some of my undertakings; due partly to stormy times, partly to misfortune, partly to mistakes, partly to revenge, but principally to *my absolute isolation.* Battling all the time single-handed, without any interested working partner to talk to, to consult with, to be checked by, and to help me in the noble work of human progress, I have not realized this mistake until too late."

HIGH AND LOW AIR PRESSURE FOR SAND BLASTS

Editor Compressed Air:

Referring to the article, "High and Low Air Pressure for Sand Blast," which appeared in your January issue at page 5137, I beg to say that some of the statements are incorrect. For instance: it requires approximately 19 horse power to compress 100 cu. ft. of free air per minute to 80 lbs., with single stage compression, and about 9.5 horse power to compress the same volume to 20 lbs., and not 15.92 and 6.28, respectively, as stated in the article. [The latter are the correct *theoretical* figures, Ed. C. A.] According to the article, a low pressure blast with a ⅜ in. sand nozzle requires 69 cu. ft. of free air per minute, while a high pressure machine according to the table in "The Foundry" from which the article in question was taken by you, requires 191 cu. ft. free air per minute at 80 lb. pressure with a ⅜ in. sand nozzle. Now, the writer happens to have positive information, obtained from actual tests with one of the latest sand blasts, that this blast, due to its construction, actually used 77 cu. ft. of free air per minute at 80 lb. pressure with a ⅜ in. sand nozzel, and that it did at least 50 per cent. more work, than a low pressure blast, of well known make did at 20 lb. pressure and ⅜ in. sand nozzle.

As stated before, according to the article, the low pressure machine in question requires 69 cu. ft. free air per minute at 20 lb, which, according to the data given, means 10.99 horse-power, since the 69 cu. ft. of free air is taken from the shop system at 80 lb. by means of a reducing valve. As a matter of fact, it takes almost 13 horsepower to compress this amount of air to 80 lb., and as the high pressure blast, requires 77 cu. ft. at 80 lb., or about 14½ horsepower, the extra 1½ horsepower over the low pressure machine will do over 50 per cent. more work than the latter.

In addition to the above advantage, the high pressure machine in question is constructed in such a way, that the moisture in the air cannot clog the blast or affect the working of the machine; furthermore, there is no sand valve, the sand supply being adjusted by the air valve, which results cannot be obtained in the low pressure, closed hopper type machines. There are other minor advantages in the high pressure machine, which together with the points stated before, give the high pressure blast decided advantange over the old low pressure blasts.

A. E. HOERMANN.

COMPRESSED AIR LOCOMOTIVES IN GERMAN COAL MINES

The circumstance that the compressed air locomotive has become a favorite method of traction in the workings of American collieries has induced one of the large Westphalian coal mining companies, the Kölner Bergwerks Verein, to make an experimental trial of the method in their Emscher pits for a district of workings where the strata are much disturbed, and consequently incapable of a very large daily output. The haulage to be done is equivalent to about 250 ton-miles in the shift of eight hours, the coal being got from four working places distant 1530, 765, 765, and 875 yards from the pit bottom respectively. The motive power—compressed air—is furnished by a two-stage compressor driven by a direct-current electro-motor of 85 horse-power, which, at 200 revolutions per minute, supplies 159 cubic feet of air at 1500 lb. above the atmospheric pressure. The air so compressed passes by an equalizing reservoir of 35 cubic feet capacity down the shaft to the main haulage road 299 yards below the surface by a line of 1½ in. wrought iron pipes, three other reservoirs of 35 cubic feet each being intercalated in the line at equal distances apart in the levels underground, to serve as filling places for the locomotives, which are supplied through reducing valves at 750 lb. pressure. The principal feature of the locomotive is the main air reservoir, a cylindrical vessel 10 ft. 4 in. long and 33½ in. diameter, of 57 cubic feet capacity, corresponding to 2910 ft. of free air compressed to the working pressure of 50 atmospheres. Below the main air vessel a smaller one is placed, with a reducing valve connection which brings the pressure down to 10 atmospheres, the initial admission pressure in the cylinders. The air vessels and the engine cylinders are carried by longitudinal cast iron framings mounted on a pair of coupled wheels of 19½ in. diameter, and a wheel base of 39.2 in. The total weight in running order is 5 to 6 tons. Under normal working conditions the power developed ranges from 8 horse-power to 12 horse-power with a maximum of 24 horse-power, and the hauling capacity is forty to fifty laden coal tubs of 2180 lb. gross, or 1245 lb. net weight, each moved on an incline of 1 in 300 at 8.2 ft. per second—5.6 miles per hour. With two locomotives at work, hauling from the four different working places, the work done in the shift corresponded to 262 ton-miles, the actual running times for the two engines being 313 min., while 642 min. were accounted for in stoppages and shunting work. The work done by the compressor during its 400 min. of running time corresponded to 374 kilowatt-hours. Under these conditions the total cost of haulage per useful ton-kilometre was 8.59pf., equal to about 3.5 cents per ton-mile. This includes, besides the outlay on power, wages, repairs, lubricating and cleaning materials, interest and sinking fund on the cost of the plant—$8,750.

During a trial extending over seven months the work has been carried on continuously without any interruption of the regular work, as even on one occasion, when the compressor was stopped for twelve hours to replace a defective valve, the engines ran to the end of the shift with the supply contained in the main air vessels without exhausting it. The pressure main has also remained wonderfully tight; the supply reservoir, when filled at 100 atmospheres at 2 p. m. one day, showed a gauge pressure of 93 atmospheres at 5.30 a. m. on the following morning. The general results of the trials may, therefore, be considered as satisfactory, as although, like all compressed air machinery, the mechanical efficiency is somewhat low, and the first cost of the primary power arrangements is decidedly higher than that called for by electric locomotives, the working cost, including wear and tear and maintenance, is considerably lower.—*The Engineer,* London, compiled from *Glückauf*.

UNITED STATES FOREST RESOURCES

The forests of the United States now cover about 550 million acres, or about one-fourth of the land of the whole country. The original forests covered not less than 850 million acres, or nearly one-half.

The forests owned by the government cover one-fourth of the total forest area, and contain one-fifth of all timber standing. Forests privately owned cover three-fourths of the area, and contain four-fifths of the standing timber. Besides having three times the area and four times the forests, the timberland privately owned is generally more valuable.

Forestry, or conservative lumbering, is practiced on 70 per cent. of the forests publicly owned and on less than one per cent. of the forests privately owned. This covers the country's forest resources as they stand to-day. Senator Smoot, chairman of the section of forests of the National Conservation Commission, in outlining the future has said:

"By reasonable thrift, we can produce a constant timber supply beyond our present need, and with it conserve the usefulness of our streams for irrigation, water supply, navigation, and power.

"Under right management, our forests will yield over four times as much as now. We can reduce waste in the woods and in the mill at least one-third, with present as well as future profit. We can perpetuate the naval stores industry. Preservative treatment will reduce by one-fifth the quantity of timber used in the water or in the ground. We can practically stop forest fires at a total yearly cost of one-fifth the value of the standing timber burned each year, not counting young growth.

"We shall suffer for timber to meet our needs, until our forests have had time to grow we shall escape permanent timber scarcity."—*U. S. Department of Agriculture.*

THE "HOT AIR" CLUB

Responding to an invitation issued by W. L. Saunders, president of the Ingersoll-Rand Company, a number of air compressor builders met on February 8th at Hotel Manhattan, New York, and took the initial steps for the organization of the "Hot Air" Club. It was the general view that there should be some way of meeting and discussing business conditions. Another object will be the study and development of compressed air machinery and the extension of the use of compressed air in industrial operations. It is expected that a permanent organization will be completed at the next meeting. The following are enrolled:

C. L. Newcomb, Rix Compressed Air & Drill Company; George F. Steedman and A. E. Hoerman, Curtis & Co.; J. W. Gardner, Gardner Governor Company; J. E. Friend, Nordberg Mfg Company; G. B. Aldrich, Platt Iron Works; A. R. Johnson and P. C. Blaisdell, Blaisdell Machinery Company; W. L. Saunders, J. P. Grace and J. H. Jowett, Ingersoll-Rand Company; William S. Fairhust, American Air Compressor Works; F. K. Copeland and A. E. Blackwood, Sullivan Machinery Company; J. W. Duntley and J. R. McGinley, Chicago Pneumatic Tool Company; J. Geo. Leyner, J. Geo. Leyner Engineering Works Company; G. Reinberg, T. E. Sturtevant and J. G. Shaw, McKiernan Drill Company; F. H. Jones and J. B. Lapman, International Steam Pump Company; C. W. Warner and Geo. Wainwright, Bury Compressor Company.

RUNNING A TWO-STAGE COMPRESSOR SINGLE STAGE

In the transactions of a South African society it is suggested that where a two-stage compressor is employed, and where at certain times of the day the air is used only for ventilation or blowing out, the low and the high pressure cylinders should be so arranged that each would take in free air and both discharge directly into the main. It is claimed that this would, in most cases, add 50 per cent. to the volume of air delivered, the coal consumption would, for a given volume of air, be reduced one third, while the air, passing through but one cylinder, would take up less oil. There would be no objection to this arrangment if the demand for the low pressure air were sufficiently frequent or protracted. With the usual cylinder ratios, however, the increased air delivery would be under 40 per cent. instead of 50.

SURROUNDING MAIN AIR PIPE WITH A STEAM COIL TO PREVENT FREEZING

By J. J. Newbaker.

We have in use a number of pneumatic tools used for chipping out the seams in steel blooms in order to produce perfect material for the manufacture of seamless tubing. The building in which the work is done is located some distance from the air compressor and the main air pipe between the two buildings is exposed to the cold weather. To heat the air to prevent freezing, it has been customary to surround a section of the air pipe with several steam pipes placed longitudinally therewith. Following out a desire to improve on this method I surrounded the pipe with a spiral coil.

Our machine department declined to undertake the winding of this coil cold on the plea that it was not practical and advised that the work be ordered from a pipe-bending shop. As this would mean considerable delay and extra expense I determined to do the job myself, which I did with entire success as follows: Not having a lathe at hand I used a pipe-threading machine instead. For a mandrel I used a 4-inch pipe 20 feet long, one end of which was held in the chuck of the machine, and the other extending to the rear supported by a forked floor stand. A hole was drilled through the pipe near the machine at a right angle to its axis and the first section of pipe to be coiled, ½ inch outside diameter, was secured to the mandrel by means of an eye bolt passing through this hole and held securely in place by a nut on the opposite end. The pipe extended through the eye bolt 6 or 7 inches and remained straight that far for convenience in connecting to the main steam line. With one helper controlling the machine, another holding a piece of 2x1½-inch flat iron on top of the pipe mandrel to gage the pitch of the coil and two holding back on the pipe to be coiled the machine was started. When the end of the first section of the coil approached within a foot of the mandrel the machine was stopped and another length of pipe attached by means of an ordinary coupling arranged to butt the two pipes squarely in the center and forced solidly together. As the coupling approached the mandrel I heated it on each side with a pneumatic torch to prevent overstrain on the joint, after which the winding proceeded cold as before until the point arrived to attach another section.

This operation was repeated until sufficient coil had been produced for my purpose. The length of the spiral pipe when finished was 13 feet, with a 2¾ pitch, except 16 inches on the last end, which was wound close. The finished coil was perfectly tight under 200 pounds gage pressure. After it was in position on the air line and heated up with steam it was covered first with heavy asbestos paper and finished with plastic pipe covering.—*American Machinist.*

VENTILATION BY INDUCED CURRENTS

At the recent meeting of the Institute of Marine Engineers, Mr. Robert Gregory read a paper bearing the above title. The system described by Mr. Gregory consisted of a nozzle placed in a series of corrugated tubes of different sizes telescoped into one another, and so arranged that at each diminishing diameter an annular space remained between the tubes of sufficient area for the vitiated air to flow in at the junction, thus carrying off the foul air or gases. The nozzle was fitted into the smallest tube, and was connected to an accumulator or reservoir of compressed air, supplied by a small air compressor. Pipes, fitted with a regulating valve, could be carried from the accumulator to each compartment or hold, and there connected to their respective ventilators, which could be used either as downcasts for fresh air or as upcasts for exhausting the foul air. Instead of compressed air a centrifugal fan could be used for supplying air to the nozzles, and by means of hot air chambers the air could be heated for the purpose of warming the cabins or saloons.

PNEUMATIC SIGNALS FOR MINES

The pneumatic system of signalling of the Westinghouse Air-Brake Co., which has been in use for many years on passenger trains, has been introduced at various mines in different parts of America to replace the pull-bell or electric systems. In the Westinghouse apparatus there is only one moving part, i. e., the small lever of the discharge valve. Another advantage is the fact that the signal sender has always the means of knowing whether the signal has been delivered to the engineer. Changes of temperature, likely to occur from change of air currents, do not affect the working of the system. If any accident should injure the signal pipe, or any parts of the apparatus which would allow a part of the air to escape, a warning would at once be automatically given to the engineer.

SOAP FOR AIR COMPRESSOR VALVES

In a paper in the Transactions of the Engineers' Club of Philadelphia dealing with Diesel engine troubles occurs the following:

We have had some trouble with the air compressors in the past. We would grind in the valves and find them a few days later caked with dirt and rust and the seats showing signs of corrosion. That trouble was entirely obviated by the use of one-quarter pint of soapy water in the low-pressure lubricator three times a day. Now we find the seats with a mirror-like polish and clean valves. This may be accounted for in the following way: It is well known that iron does not oxidise rapidly except in the presence of carbon dioxide and moisture. The carbon dioxide in the compressed air, dissolved in the moisture condensed out of the compressed air in the intercooler, and thus formed weak carbonic acid, which in company with the oxygen of the air created excessive oxidation. The alkali in the soap was sufficient to neutralise this carbonic acid and consequently the oxidation did not occur.

TRADE PUBLICATIONS

Crosby Testing Apparatus, Crosby Steam Gage & Valve Company, Boston, 20 pages, 4¾ by 7 inches. Describes gages and pumps for testing for vacuum or for pressures up to the highest.

Lubricating the Motor, Joseph Dixon, Crucible Company, Jersey City, N. J., 24 pages 5 by 8½ inches. The pamphlet is divided into chapters which treat in detail on the use of flake graphite in motor service. There is a chapter on tires, also chapters, self descriptive, entitled "Overhauling the Car" and "Motor Boat and Cycle."

ELECTRIC PUMP GOVERNORS. Instructive Pamphlet T 5042. Westinghouse Traction Brake Company. 20 pages. 4¾ by 7 inches. The apparatus described is for automatically controlling the operation of motor driven air compressors between predetermined minimum and maximum air pressures.

NOTES

A pocket aneroid barometer invented by J. C. Asten, Upper Norwood, S. E. Eng., notes differences of elevation of 10 feet up to 10,000 feet. The dial is 2½ in. in diameter.

There is a "dispute" at the Dunkerton, England, colliery, with no prospect of an immediate settlement, the origin of the trouble being a demand of the boys for an additional halfpenny (1 cent) per ton on the standard wages.

Hot-air heating by utilizing the waste heat of a gas engine is a feature at a Pennsylvania manufacturing plant. Both the exhaust gases and the jacket cooling water are used to heat fresh air, which is circulated by a fan.

In one district in Canada, the mine managers have found it advisable from the standpoint of economy, to have their ventilating fans so constructed that they can run them one way in summer and the reverse in winter.

The Government Mining Engineer reports that there are installed on the Rand, South Africa, 186 air compressors, having an aggregate I. H. P. of 72,400, a free air capacity of 600,000 cu. ft. per min., and costing $3,750,000 per annum to operate under normal conditions.

Small air hoists mounted on a bar are used in some of the mines at Mount Morgan, New South Wales, Australia. These are easily put up, the bar being placed vertically, and are used instead of a windlass in sinking winzes. These hoists are simple in contruction, are light and can be moved easily.

Compressed air is so ready and alert to do things, and does so many things so creditably that new stunts are being proposed for it continually, not always by those most familiar with its successful employment. A man in Ohio has a patent for blowing people off railroad tracks to avoid running over them.

While most people know that Pliny states that the ancients broke ore in mines by pouring vinegar on the heated face of rock, it is less generally known that he further states that they also used bars of iron as battering rams to break the ore from the face. These bars were heavy and several miners were required to each battering ram.

The English Admirality have experimented with an ingenious device comprising a small motor air pump for the detection of dangerous gases on board submarines. The pump stationed at an indicator draws air through pipes laid to various parts of the boat, and should dangerous gases exist, warning is given by a delicate recorder.

The Mexican government has appropriated $50,000 for a monument to Jesus Garcia, a locomotive engineer employed in the railroad yards at Nacozari, Sonora, who, on Nov. 7, 1907, hooked his locomotive to a burning car of dynamite and pulled it out of the town. He was blown to death, but his act saved the town and many lives.

A miner's inch of water, or that quantity which will flow through an opening an inch square with a head of four inches above the opening, will irrigate from five to ten acres of land for agricultural purposes. This is equal to a flow of about 13,000 gallons in 24 hours. Fifty miner's inches equal a flow of one cubic foot of water per second.

The area of the more accessible coal-fields of the United States is about 327,000 square miles, and they carry an estimated content available for future use of nearly 2000 billion tons. The rate of consumption cannot be predicted with certainty, but if the rate of increase that has held for the last 50 years is maintained the supply of easily available coal will be exhausted before the middle of the next century.

An engine built in 1808, or over a hundred years ago, for a British firm, has just failed by the breaking of the crank shaft. The company which built the engine has been called upon to make repairs, and after an examination of the rest of the engine, it was found to be in excellent condition, so that it has been concluded to set it to work again as soon as the repairs have been completed.

Announcement is made of the consolidation of the American Blower Company, of Detroit, and the Sirocco Engineering Company, of New York. The plants at Detroit, Mich., and Troy, N. Y., will continue in full operation and all business will be transacted under the style and name of the American Blower Company (Incorporated under the Laws of the State of New York).

When certain patents expire next year the manufacture of aluminum will be open to whoever may choose to engage in it, and the chances are that the industry will make enormous strides in the next few years. In Europe the patents expired last year and the metal is selling about 13 cents a pound. The duty into the United States is 8 cents and here the price is about 23 cents.

The C. & G. Cooper Company, Mt. Vernon, Ohio, has received a contract from the Tennessee Coal, Iron & Railroad Company for a 3,000-hp. cross compound Corliss steam engine, to be installed in its electrical power house at Ensley, Ala. The cylinder dimensions are 42 and 78 x 54 in. The engine is arranged for direct driving a 2,500-kw. Crocker-Wheeler alternator. The unit will operate at 83½ rev. per min. and be capable of developing 4,500-hp. continuously when necessary.

There recently occurred near Mauch Chunk, Pa., the largest cave-in that has ever been known in the anthracite coal region. The side of the mountain over the Panther Creek Mine of the Lehigh Coal & Navigation Company caved in. This mine has been on fire in the heart of the mountain for forty years and the company has spent large sums in trying to extinguish it. The burning away of the coal has eaten out the support for the surface. It is said that the sound of the collapse was heard for twenty miles.

To show how great may be the generation of static electricity in German factories, Prof. M. M. Ritcher has drawn sparks 1 in. to 1½ in. long from a 5-in. belt on a wheel making 1,000 revolutions a minute. The risk of explosion in dust or gases seems to have been overlooked. Coating with bronze or aluminum powder prevented static charges, while a weekly application of acid-free glycerine was a remedy and added durability to the leather.

The average yield of peanuts in oil, according to quality and origin, is from 38 to 50 per cent. of their weight. The first pressure gives from 16 to 18 per cent. of high-grade edible oil; the second, from 7 to 8 per cent. of second grade, after which from 7 to 10 per cent. of industrial oil is also obtained. The remaining cake is often also treated by the sulphur of carbon or tetrachlorure of carbon process, which extracts a further 7 to 10 per cent. of low-grade industrial oil.

If a conscientious housewife suspects that the fresh green of her canned vegetables is due to the presence of copper in the goods [bads?] the quantity of copper may be determined by incinerating the vegetables, leaching the ash with nitric acid, evaporating to dryness, dissolving the residue in hydrochloric acid, neutralizing the solution with ammonia, acidifying it slightly with hydrochloric acid, and precepitating the copper with zinc in a vessel of platinum.

A new alloy has been brought out in France, known as Invar, which has the valuable property of having practically no expansion; it also is not magnetic, and it does not rust, it being thus specially adapted for various purposes. Nickel steel is the base of the alloy, and up to 20 per cent. of nickel, the expansion is about the ordinary. It then increases up to a value of 24 per cent., reaching a minimum value at 36 per cent. of nickel, then rising and taking the normal value for a 50 per cent. alloy. It is the 36 per cent. metal which has the curious properties, and its expansion is almost zero.

being 17 times less than that of steel and about the same as for melted quartz.

That air brake hose gets hard in cold weather is generally due to freezing. If we could get some kind of rubber that would not freeze we would be very happy. Crude rubber will freeze at about 20 degrees F., and vulcanized rubber freezes at about zero. All rubber companies have experimented in different ways to prevent this, and they have added oils and all kinds of things that do not freeze so readily, but in this country the temperature gets so low that it frequently gets beyond us.

No snake will tackle a hair rope. It is the only sure protection against them. Somehow this idea has permeated the minds of the East Indians and now they buy these ropes for protection against the poisonous snakes with which that country abounds. Large numbers of these ropes are shipped to India and adjoining countries each year. Over there they are coiled on the floor around the bed at night and the occupant can lie down in comfort, certain that no snake will ever attempt to pass over that hair rope. It is about the only way any one can be sure of a night's sleep undisturbed by visits from snakes in that country.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

JANUARY 5.

908,445. PNEUMATIC GRAIN-CONVEYER. William F. Carlton, Advance, Mo.

908,515. PNEUMATIC HAMMER. Harry B. Stocks, Didsbury, Manchester, and John R. Webb, Jr., East Cliffe, Dover England.

908,644. APPARATUS FOR LIQUEFACTION OF GASES AND SEPARATION OF AIR INTO COMMERCIAL OXYGEN AND NITROGEN. Gabriel A. Bobrick, Los Angeles, Cal.

908,690. DIVING-GEAR OR THE LIKE. Alois Neubert, New York, N. Y.

908,692. AUTOMATIC GOVERNOR FOR AIR-COMPRESSORS. Clarence Norland, Los Angeles, Cal.

908,794. AERONAUTIC APPARATUS. George A. Metcalf, Malden, Mass.

908,866. AIR-LOCK. Henry Japp, New York, N. Y.

908,869. DUMPING-VEHICLE. John W. King, New York, N. Y.

4. In a vehicle, a supporting frame, a dumping body thereon, means adapted to automatically lock said body in normal position, fluid actuated pistons and means actuated by said pistons adapted to unlock the body previous to imparting movement thereto, positively move it horizontally and allow it to dump of its own momentum and then positively return it to normal position substantially as described.

908,877. APPARATUS FOR RECEIVING SUBMARINE SIGNALS. Charles H. Mundy, Metuchen, N. J.

908,920. MOTOR-ACTUATED HAND-TOOL. William C. Whitcomb, Chicago, Ill.

908,921. MOTOR-ACTUATED HAND-TOOL. William C. Whitcomb, Chicago, Ill.

908,922. MOTOR. William C. Whitcomb, Rochelle, Ill

908,963. HUMIDIFYING AND AIR-MOISTENING APPARATUS. Stuart W. Cramer, Charlotte, N. C.

908,964. HUMIDIFIER AND AIR-MOISTENING APPARATUS. Stuart W. Cramer, Charlotte, N. C.

908,968. PNEUMATIC CALLIOPE. Samuel V. Day, Whichita, Kans.

908,991. ANIMAL-CLEANING APPARATUS. Conrad Hammer, Buffalo, N. Y.

908,992. PORTABLE VACUUM DUST-EXTRACTOR. Charles J. Harvey, Kidderminster, England.

909,056. TRACK-SANDER. John W. Brady, Neodesha, Kans.

JANUARY 12.

909,163. COMPOUND PUMP. John Desmond, Chicago, Ill.

909,183. VACUUM-PUMP. Charles L. Heisler, St. Marys, Ohio.

909,259. ROCK-DRILLING ENGINE. John A. Traylor, Denver, Col.

909,373. PRESSURE-CONTROLLING VALVE FOR TIRE-PUMPS. John Desmond, Chicago, Ill.

909,397. BALLON OR AIR-SHIP. Alexandre F. Godefroy, Mexico, Mexico.

909,427. VARIABLE-VOLUME AIR-COMPRESSOR. Max Kurth, Franklin, Pa.

909,551. SIGNAL APPARATUS. Clyde J. Coleman, Rockaway, N. J.

1. In a railway signal apparatus the combination of a signal nomally at safety, and having a normal bias to danger, a pressure storage tank containing *liquefied gas*, and a gas pressure-applying chamber in operative connection with said signal, and in controllable communiciation with said storage tank, whereby gas may be supplied from said storage tank to said gas pressure-applying chamber to move the signal to safety, substantially as described.

909,632. AIR-HEATER. August Mathis, Chicago, Ill.

909,681. AIR-SHIP. William Rumble, New York, N. Y.

909,740. PNEUMATIC-TOOL LUBRICATOR. John C. Beckfield, Pittsburg, Pa.

909,790. PNEUMATIC-TOOL COUPLING. Alexandre Herbert, Montpelier, Vt.

909,809. AIR-BRAKE SYSTEM. Herman W. Ley, Boulder, Colo.

JANUARY 19.

909,907. AIR OPERATED AND CONTROLLED MECHANISM. James S. Johnston, Utica, N. Y.

909,923. VALVE MECHANISM FOR ROCK-DRILLS, &c. Joseph L. Mitchell, Denver, Colo.

909,950. TESTING APPARATUS. Frank Schreidt, Mansfield, Ohio.

910,036. TURBO-BLOWER. Albert L. Wolfson, New York, N. Y.

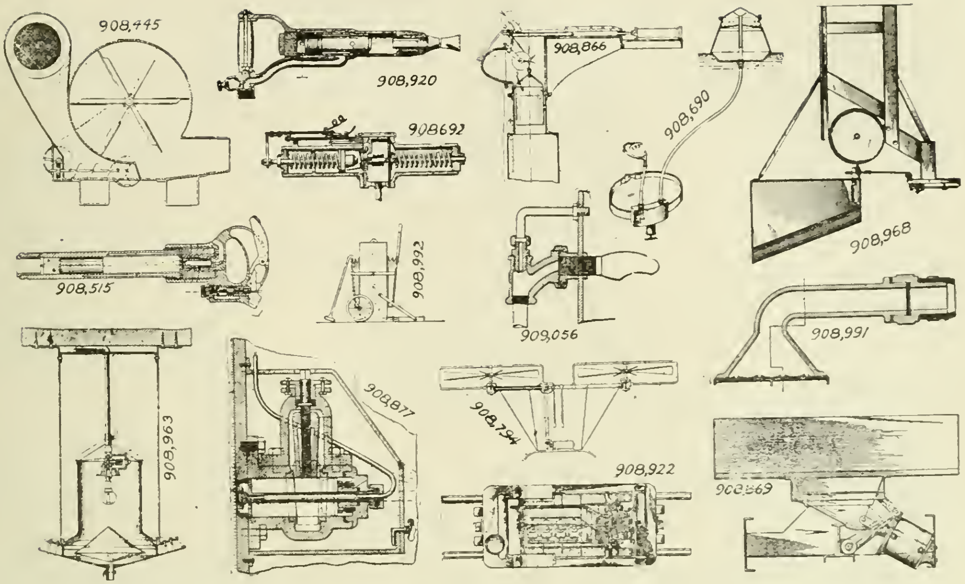
910,045. AIR-WASHER. Frank E. Donaldson, Chicago, Ill.

910,175. ROTARY COMPRESSOR. Henry W. N. Cole, Brooklyn, N Y.

910,223. THROTTLE-VALVE FOR PNEUMATIC HAMMERS. Reinhold A. Norling, Aurora, Ill.

910,224. REVERSIBLE DRILL-THROTTLE. Reinhold A. Norling, Aurora, Ill.

910,277. APPARATUS FOR ELEVATING GOLD-BEARING DEPOSITS FROM RIVER-BEDS, Albert L. Eliel, San Francisco, Cal., and Oscar H. Eliel, La Salle, Ill.



Pneumatic Patents, January 5.

1. An open-ended, vertically-arranged, hollow shaft and a frame in which the said hollow shaft is mounted so as to slide vertically, in combination with mechanism for moving said hollow shaft vertically and horizontally and imparting to it reciprocating rotary movement and an air tube connected with the bottom end for introducing compressed air into said hollow shaft when partially submerged.

910,341. AIR-BRUSH. Olaus C. Wold, Chicago, Ill.

910,342. AIR-MOTOR. Daniel B. Wood, Almyra, Ark.

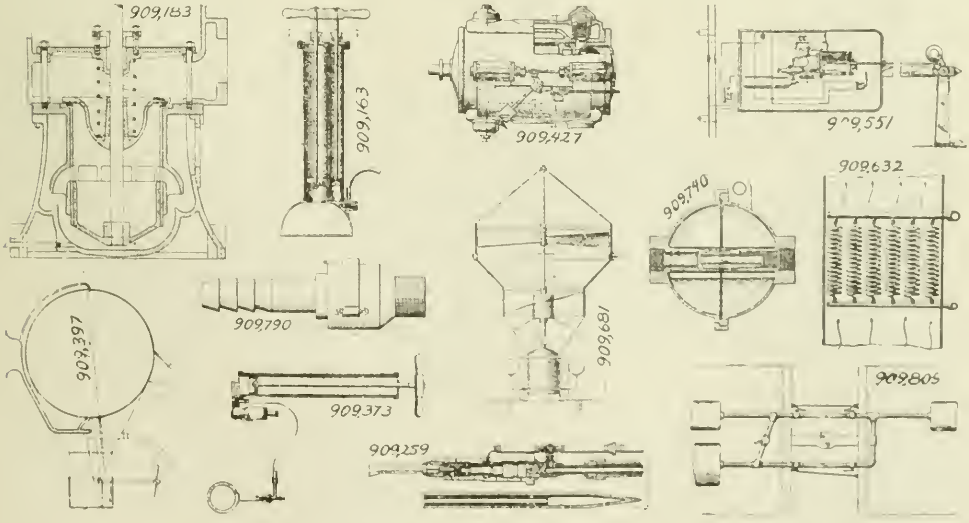
910,373. PNEUMATIC CLOCK SYSTEM. Augustus L. Hahl, Chicago, Ill.

910,402. AIR-BRAKE SYSTEM. George Macloskie, Schenectady, N. Y.

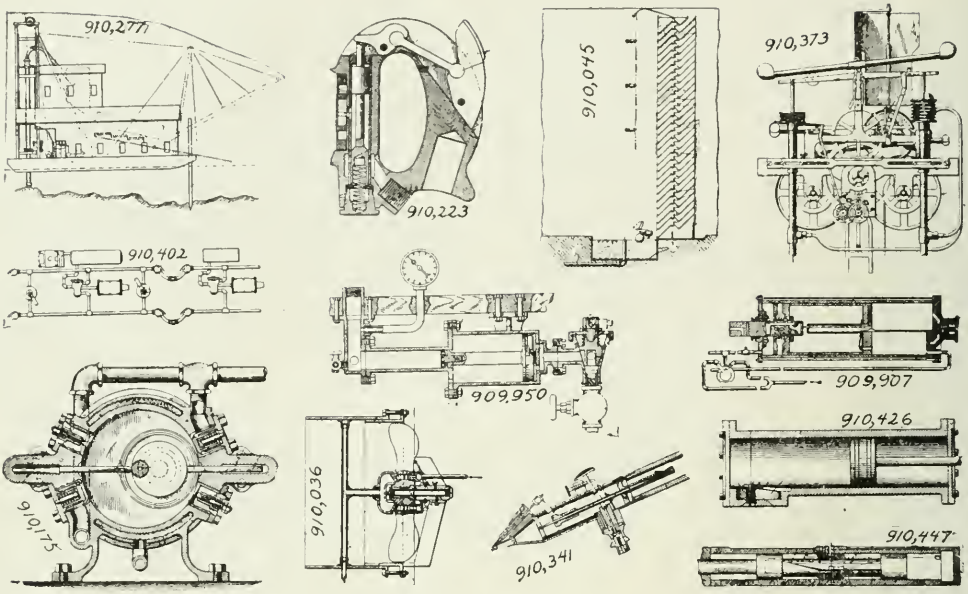
910,426. FLUID-PRESSURE HOIST. Earl D. Smith, Delphi, Ind.

910,428. TURBO-PNEUMATIC DRILL. John W. Smith, Philadelphia, Pa.

910,447. DISTRIBUTING-VALVE FOR PERCUSSIVE ROCK-DRILLING MACHINES. Anthony J. Bant and Henry Gullett, Johannesburg, Transvaal.



Pneumatic Patents, January 12.



Pneumatic Patents, January 19.

JANUARY 26.

910,488. AERIAL NAVIGATING APPARATUS. John Bernard, Richmond, Va.

910,500. TUNNELING-MACHINE. Charles A. Case, New York, N. Y.

910,525. METHOD OF AND APPARATUS FOR DRYING AIR. Horace C. Gardner, Chicago, Ill.

910,560. PERCUSSION-MACHINE. Wilhelm Mauss, Brakpan, Transvaal.

910,683. AIR-SHIP. Paul Hochstrasser, Salt Lake City, Utah.

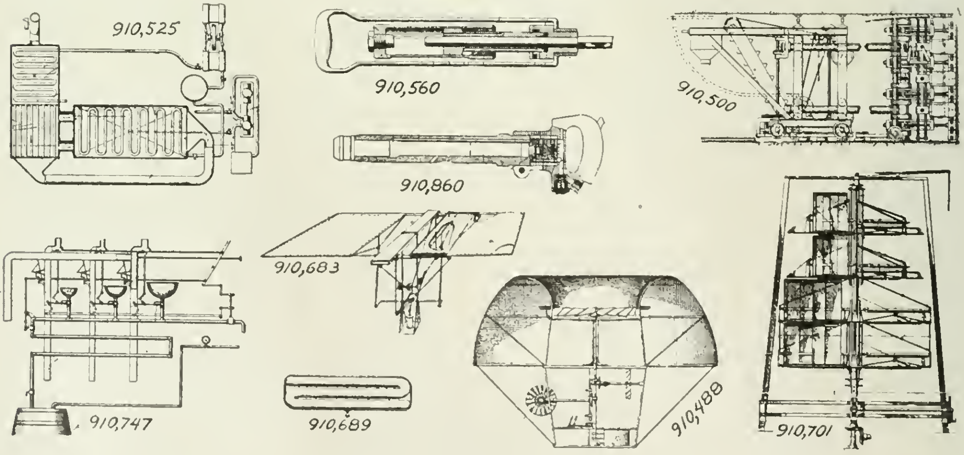
910,689. PNEUMATIC PAD FOR HARNESS. James M. Kelly and Frank L. Rankin, Greensburg, Ind.

910,701. WINDMILL. Anastasics Macris, Juneau, Alaska.

910,747. LIQUID-VENDING APPARATUS. Freddie Turner, Marquisville, Iowa.

1. The combination with a liquid receptacle, and means for admitting compressed air thereto, of a series of measuring cups, a liquid service pipe leading from said receptacle, a series of branch pipes leading from the service pipe to the measuring cups, a normally closed valve for each of said branch pipes, and means for selectively operating said valves to control the admission of liquid from the service pipe to said measuring cups.

910,860. IMPACT-TOOL. Charles B. Richards, Cleveland, Ohio.



Pneumatic Patents, January 26.

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC.

Vol. XIV APRIL, 1909 No. 5

THE LARGEST WINDMILL IN THE UNITED STATES

Several years ago a Dutch windmill was built in Golden Gate Park, San Francisco, close to the tossing waves of the Pacific. So picturesque was its appearance and so successful its operation that its mate has been recently constructed several hundred feet to the south. These are the two largest windmills in the United States, the original having a diameter of 102 feet and the new of 114. The sweeping arms of these transplanted scions of Holland greet the mariner entering the harbor of San Francisco from the Pacific. They pump water for the various artificial lakes in which this great park abounds.

BIGGEST WINDMILL IN THE UNITED STATES.

The powers of Nature are valuable in proportion to their economy and their dependability. There is probably nothing cheaper than wind, and nothing as unreliable. But in this case the trade winds from the Pacific spring up about the time the dry season begins and blow a steady gale until the fall rains set in; their gentle insistence drives this great mill and pumps much of the water required during this period of natural drougth. With their utility and dependability proven by use, they combine the rare quality of being both useful and ornamental.

The new mill stands 85 feet from the ground to the centre support of the arms, these having a further radius of 57 feet, which gives a total height of 142 feet. Their tower support is essentially a truncated, octagonal pyramid, substantially built and covered with slate. The base is constructed of concrete strongly reinforced with steel rails. The basal diameter is 60 feet, gradually diminishing to 24 feet at the turret top. Within this five storied tower, whose walls taper from a thickness of four feet at the base, is placed a great pump, having a capacity of 60,000 gallons hourly. Each story of the structure provides a support for the vertical shaft which transmits the power from the windmill to the pump.

The four arms, or sails, of the mill turn a great steel shaft, twenty-two feet long and thirteen inches in diameter to which they are attached by a heavy iron hub. Each of these arms consists of a long spar of Oregon pine, upon which are mounted wind-boards and sails to give an effective wind area of 516 square feet for each arm, making a total of 2064. This maximum may be considerably reduced by furling the canvas in case of high winds. A small steering wheel with a diameter of sixteen feet keeps the power wheel always in the wind, just as the helmsman controls a ship by the rudder. The steering wheel stands at right angles to the large mill so that its blades receive no energy as long as the large mill is directly to the wind. Should the wind direction shift ever so slightly, the small wheel turns and pulls the power mill into the wind again, its motion being transmitted through four sets of gears to the revolving turret, giving a ratio of 7,500 to 1. A double band brake, lever-operated, has been substituted for the half brake of similar type, which proved insufficient to hold the mill if it was to be stopped.

Experience in Holland has shown that a maximum of power is obtained with a slight elevation of the axis above the horizontal, and consequently the main shaft has been mounted at an angle of twelve degrees, thirty minutes. The power varies of course with the velocity of the wind and the extent of sail area exposed. The following table has been compiled for various wind velocities at a maximum sail area:

Miles per hour.	Horse power.
4	0.383
6	1.283
8	2.193
10	5.953
11	7.473
12	10.32
14	16.35
16	24.37
18	34.65
20	47.63
25	92.91
30	160.75
40	381.08

These results are theoretical. The sails are furled as the wind velocities exceed 20 miles per hour. The view is taken looking out of a tunnel which is one of the scenic features of the park.—*Journal of Electricity, Power and Gas*, San Francisco.

A NEW SUB-AQUEOUS ROCK-BREAKING MACHINE WITH HAMMER ACTING IN COMPRESSD AIR

It being understood from the title that compressed air is an essential agent in the operation of this apparatus, a first glance at the sketch, Fig. 1, may suggest that here is simply an enormous pneumatic hammer, similar in principle of operation to the familiar portable hand manipulated pneumatic hammer. The function of compressed air in this case, however, is entirely different. Compressed air does not operate the hammer, but merely displaces the water in the vertical tube of caisson in which the hammer travels, so that it may have a free drop upon the chisel, instead of losing its force by dropping through the water, as has been the practice previously.

The cuts herewith we reproduce from *Engineering News*, and the description following is an abstract of an article contributed to that journal by Barton H. Coffey, M. E., 71 Wall St., New York.

This rock breaker, entirely of American origin and development, and embodying many novel and interesting features, has lately removed some ledges in the 35 ft. ship channel in Boston harbor; a harbor badly obstructed by reefs, which it is impossible to avoid in

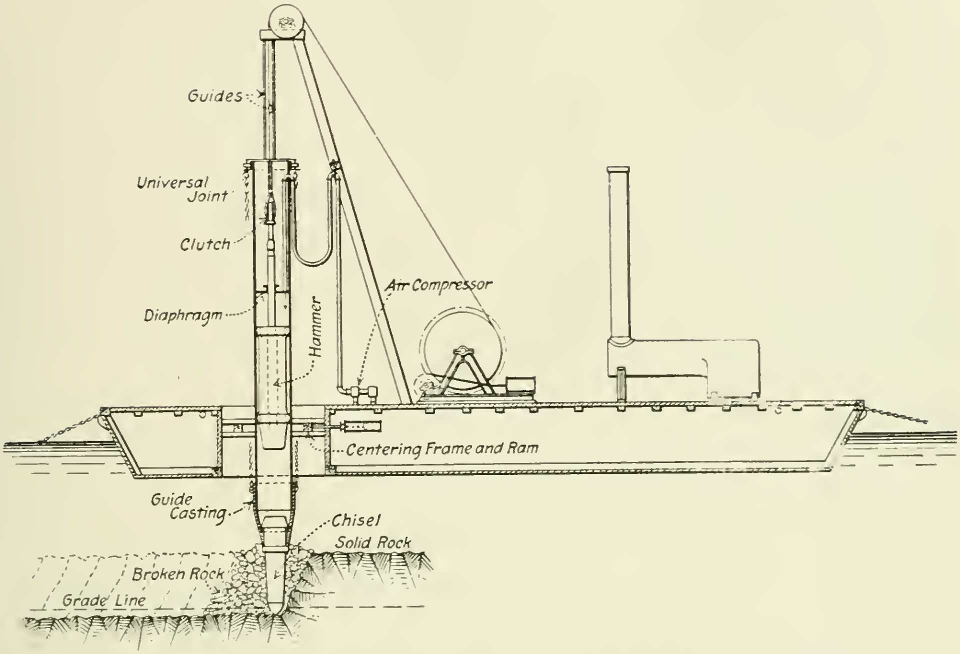


FIG. I.—SUA-AQUECUS ROCK CHISEL WORKING IN COMPRESSRD AIR.

any comprehensive scheme of improvement. The ledges consist of metamorphic slate, varying from markedly stratified rock to that almost igneous, the stratification inclining upstream and lying about 15 degrees from the vertical. It is all hard, and some of it exceedingly so.

Practically all of the work here has been done heretofore by drilling and blasting, but the high cost and slow progress led to attempts to break the rock with chisel machines. Chisels of the exposed drop type were tried on certain contracts at 27 ft. mean low water, but they failed utterly.

To the ordinary exposed drop chisel, shown diagrammatically in Fig 2, which is lifted and drops through the water upon the rock, there are three objections:

First, the water resistance is serious. It increases as the cube of the velocity, checks the fall of the chisel and deadens the blow.

Second, at each blow the chisel must penetrate the rock already broken, resulting in the useless expenditure of a portion of its energy in breaking the broken rock still finer. The efficiency of the machine falls off so rapidly that it is found to be impracticable to break up the rock in layers over 3 ft. thick.

Third, as it has not been found feasible to guide the falling chisel, the successive blows are not delivered on the same spot, but are scattered over a considerable area, thus losing the enormous cumulative advantage in splitting the rock produced by the following-up effect when the blows are concentrated on a fixed point.

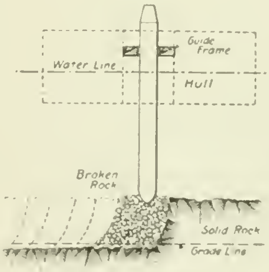


Fig. 2. Open Chisel Machine.

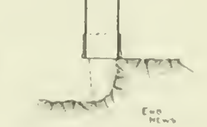


Fig. 3. Air Chamber Chisel.

These defects are overcome by the new machine shown in outline in Fig. 1. It will be understood that the framing here shown is incomplete. The chisel is made short and light, and it rests permanently upon the rock when in operation. The upper portion of the chisel is embraced by a guide casting, in which it slides freely with a limited vertical movement, a shoulder on the chisel supporting the guide, and the chisel head preventing the chisel from dropping when the guide is lifted. The guide is a sliding fit upon the end of the tube, which it supports upon an interior shoulder. The upper end of the tube is fitted with a universal joint, provided with shoes adopted to slide in the vertical guides. The tube extends through a well in the hull of the barge, the dimensions of the well being considerably larger than the tube, to permit local movement of the latter. The entire weight of the assembage is thus concentrated upon the chisel point resting on the rock, and it still is free to move both vertically and laterally.

The tube or caisson is divided into two compartments by a diaphragm, the upper compartment being open to the atmosphere, while the lower compartment or working chamber is kept free from water by the compressed air which enters by the pipe connected to the diaphragm, fills the compartment and escapes through openings in the bottom of the guide.

The heavy hammer is lifted and dropped upon the head of the chisel, driving it into the rock. The tube is the only guide for the hammer, which is provided with ample openings in its bearing rings to allow free passage of the air up or down as the hammer reciprocates. The hammer is lifted by a rod which passes through the stuffing box in the diaphragm. This rod is provided with a barbed end, which is seized by a clutch attached to the hoisting tackle. At any desired point the clutch is tripped, dropping the hammer upon the chisel. The upper chamber of the tube is provided with guides for the clutch. The only retarding influences over a free drop in the open air are the friction against the walls of the tube, friction of the air passing through the openings in the hammer, friction of the stuffing box and the unbalanced air pressure upon the area of the lifting rod; the sum total of those in percentages of the kinetic energy of the hammer is negligible, and it may be said that the hammer develops at impact practically the full theoretical effect at any drop. The best evidence of this is in the fact that the exposed drop chisels are generally operated at 8 ft. drop, whereas 3 ft. is ample with the pneumatic chisels.

After a penetration is completed the releasing gear is not allowed to trip the clutch, and then the hoisting first lifts the hammer up to touch the diaphragm, and further hoisting raises the tube and all together, and the machine can then be moved to the next spot.

On beginning a penetration, the tube is lowered through a sliding frame which centers it with the guides, thus insuring accurate spacing of penetrations. As soon as the chisel reaches the rock the frame is withdrawn, permitting lateral motion while the breaking is in progress. As the chisel point follows the line of cleavage, and as this is rarely vertical, there is a gradual horizontal displacement of the chisel point while the penetration is in progress. In Fig. 3 a chisel point is shown attached to the hammer, the guides and chisel at the bottom then being dispensed with.

The machine working in Boston harbor in depths of 47 feet has made penetrations of six and seven feet without difficulty, thus doubling the volume of rock broken at a single passage of the machine as compared with the work of the exposed drop chisel. The efficiency of this machine is quite independent of the depth, as proved by the work on the 35 ft. channel at Boston. As this depth is at mean low water and as the tides at Boston rise from 9 to 12 ft., the work must be done to maximum depths of 47 ft.

The general dimensions of the machine as used are as follows:

Hull, 32 ft. x 90 ft. x 12 ft. deep; frame, 65 ft. high. The hammer is a single steel casting, weighing about 12 tons, and does its work with a drop of about 3 ft., 140 drops per hour. The vertical caisson is of welded steel, weighing with its attached parts about 12 tons. The air compressor is 12 in. dia. by 9 in. stroke, double acting, the working air pressure varying with the submergence and being about 1 lb. for each two feet of depth under water. Large volumes of air are used, this all escaping at the bottom of the tube or caisson, inducing water currents which sweep away loose material overlying the ledge. It is not necessary to say anything here about the means for precisely locating and securely holding the float.

The machine has been operated in New York harbor at 22 ft. low water in the micaceous schists of that vicinity, and is now engaged on a contract on the Penobscot River, Maine, amounting to about 9,000 cu. yds. of shallow cutting in metamorphic slate. The patent rights on the apparatus are controlled by the Submarine Company, 71 Wall St., New York.

The Roosevelt dam now being built by the United States Reclamation Service, on Salt River, Ariz., when completed, will be far the largest artificial lake in the world. It will impound 1,300,000 acre-feet of water, or 423,577,440,000 gallons. At present an Indian reservoir, which is filled only once in about 20 years, is the largest, with a capacity of 950,000 acre-feet.

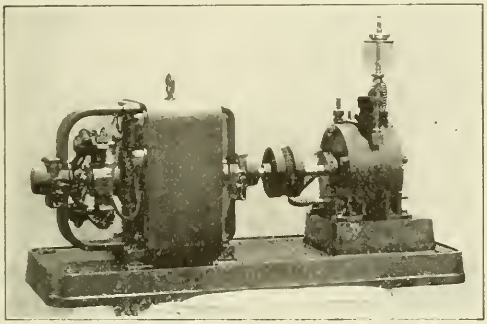


FIG. I.—ROTARY COMPRESSOR.

GERMAN ELECTRIC DRIVEN PUMPS AND COMPRESSORS

By Frank C. Perkins.

For driving rotary pumps or compressors the electric motor is especially desirable, as current can be obtained without great expense, and the apparatus gives good efficiency. Fig. 1 shows a German air compressor directly coupled to a continuous current bipolar motor, and supplying air at from 1.2 to 2 atmospheres, and Fig. 2 shows a four pole direct current motor driving a vacuum pump which reaches an absolute pressure of 1.5 mm. (.059 in.) of mercury column.

The electric motor is very satisfactory as a source of power for portable work as it can be mounted on a truck and moved to any place where the machine which it drives is needed. Fig. 3 shows a portable motor and air compressor, the receiver being placed underneath the car, and the necessary switch, cut-outs and gage at the side, the reel carrying sufficient cable with electric connections for tapping a light or power circuit wherever convenient.

EDISON ON EDUCATION AND ACHIEVEMENT

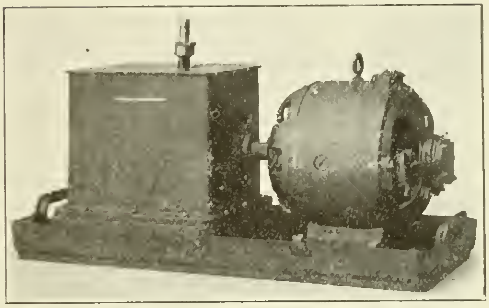


FIG. II.—ELECTRICALLY OPERATED VACUUM PUMP.

Mr. T. A. Edison seems to be learning to talk, and when he talks he has something to say. In a recently reported interview he gives his views on education as preparatory to engineering occupations, and his estimate of the value of a college education is not high.

In scientific work, as in all other work, he says, the chief factor of success is the power of sticking to a thing. I attribute all that I have accomplished to the fact that I hold on where most persons get discouraged. Another fundamental characteristic for a successful scientist is the power of being a close observer. For instance, while I am experimenting to find some special thing by my close observation I often see dozens of other things not connected with what I am after, and thus the scientific field is one that is constantly expanding and broadening out into new fields.

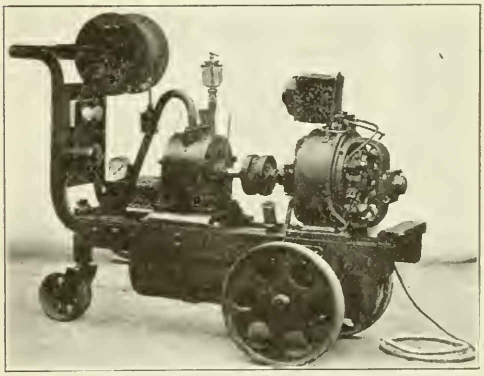


FIG. III.—PORTABLE COMPRESSOR.

"Unlimited opportunities are offered in the scientific field for good practical scientists, and the higher positions are awaiting the skilled men. For all the $3,000 or $4,000 positions there are many capable candidates, but when it comes to the $10,000, $15,000 or $20,000 positions it is very hard to find the right man. Accordingly at the present time many important high salaried positions are vacant for want of enough capable scientists. In fact the modern times are always demanding a higher intellectual standard for all important positions.

"What the country needs now is the practical, skilled engineer who is capable of doing anything. In three or four hundred years, when the country is settled and commercialism is diminished, there will be time for the literary men. At present we want engineers, industrial men, good business managers and railroad men. In fact there is a field for fine men everywhere.

"One of the chief attractions of scientific work is that it is extremely and constantly interesting. A literary career often becomes monotonous, while scientific work is always increasing in interest. This spirit is shown, for example, by a machinist who toils at one thing all the time, but just set him at some experiment for a while and his keen interest in the work is at once manifest.

"My greatest objection to a college education for a scientist is that academic or classic learning is old and does not keep progress with the times. It does not teach a man to think practically. Science is deeper than Latin or Greek. It is easy for a lawyer to get along with small ability, but a poor engineer is found out in less than six weeks and unless he has learned to think for himself and understands his work he cannot succeed.

"A scientific education is valuable not alone to an engineer but also to a business man, for it teaches practical lessons. On the other hand, Latin and Greek are of no value to the practical business or industrial man. If colleges could teach their men to become first class draughtsmen that would be a great advance, for skilful draughting implies that a man can do anything. In my opinion the best course offered at present in the colleges is economics, for this strengthens the mind in many ways and gives one a clear conception of things as they really are.

"In conclusion I say that as it is impossible to learn everything in the world let each man pick his course, and with care then follow it out. As for the literary or professional man, although this is not the time for the former, he should follow a classical course such as is offered at Yale, Harvard, Princeton or some of the other colleges."

THE NEW BERGEN TUNNEL OF THE LACKAWANNA R. R.

The Delaware, Lackawanna & Western Railroad has just opened to traffic its new two-track tunnel through Jersey City Heights. The old tunnel will now be used exclusively for outbound trains and the new one for incoming trains. The new tunnel is about seven-eighths of a mile long, and the work presented no unusual difficulties beyond the hardness of the solid trap rock. Work was begun in March, 1906, with electric drills (not electric air) and a year later the contract was annulled by mutual consent and the railway company assumed the work. The first thing done was to change the drills from electric to compressed air, a compressing plant being installed near the western portal.

There are two vertical openings 85x100 ft., extending 80 ft. to the surface, and walled with 18 in. of concrete. There are also two ventilators, and these with the larger openings keep the tunnel practically clear of smoke and gas. The entire base is lined with concrete a foot thick, and drain pipes are placed at regular distances embedded in the concrete to allow the water from the rock to flow away without damage to the masonry. Pipes to carry wires have been embedded beneath the tracks, and bolts in the ceiling anticipate the future when electricity may be adopted for motive power.

INDICATOR CARDS FROM VARIABLE VOLUME AIR COMPRESSOR

In our issue for September, 1908, page 5003, we presented illustrations and description of a large Canadian variable volume air compressor installed at a British Columbia copper mine. The indicator cards on the opposite page are from that compressor, taken as running on its regular daily work. They were sent to the *American Machinist*, from whose pages we reproduce them without change of scale, by Mr. H. V. Haight, chief engineer of the Canadian Rand Drill Company, the designer of the compressor. We are thus relieved of all responsibility as to the cards, which cannot fail to in-

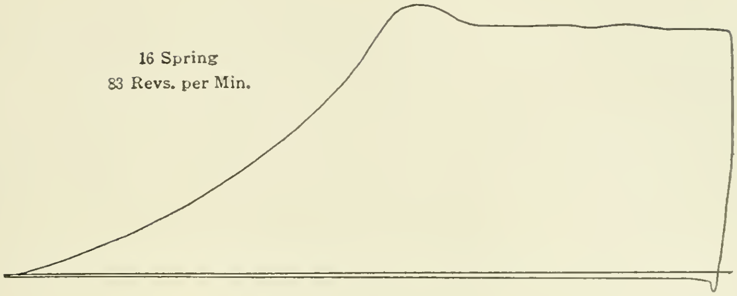


FIG. 1. Compressing

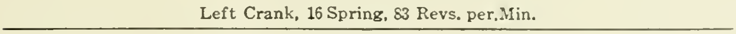


FIG. 2. Unloaded

LOW-PRESSURE CYLINDER CARDS

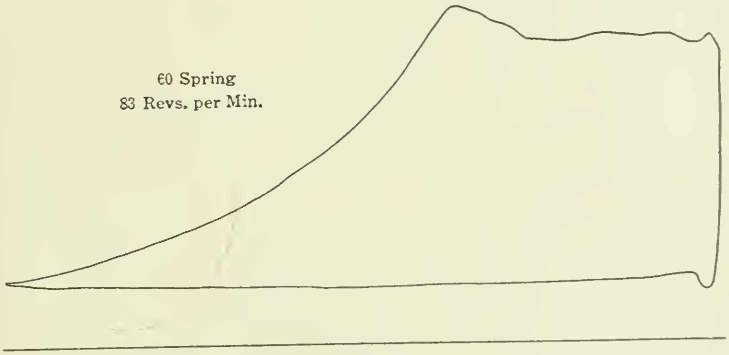


FIG. 3. Compressing

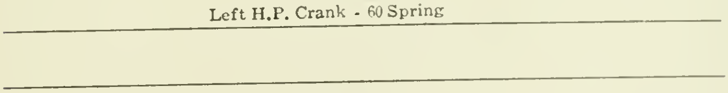


FIG. 4. All Unloaded

HIGH-PRESSURE CYLINDER CARDS

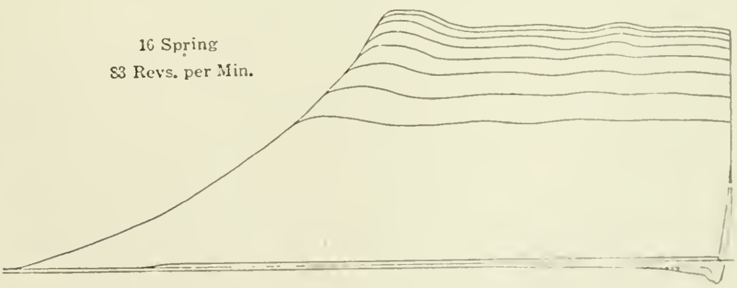


FIG. 5. LOW-PRESSURE CYLINDER PICKING UP LOAD

terest those who have to do with large air compression problems.

It will be recalled, Mr. Haight says, that the machine shown was a 25x16x36 in. duplex-tandem air compressor, having a capacity of about 3400 cubic feet, and driven by a 600 horse-power motor by means of a rope drive. The special feature of the machine is the unloading device by which one-quarter of the load is thrown off at a time, by holding open one high-pressure Corliss inlet valve and one low-pressure Corliss inlet valve at each step. In reality the low-pressure Corliss valve is held open slightly before its corresponding high-pressure valve. This makes the unloading and the taking up of the load again come in practically eight steps and allows a little drop in the intercooler pressure between the four regular steps. This is well shown in Fig. 5 where the low-pressure cylinder is taking up its load.

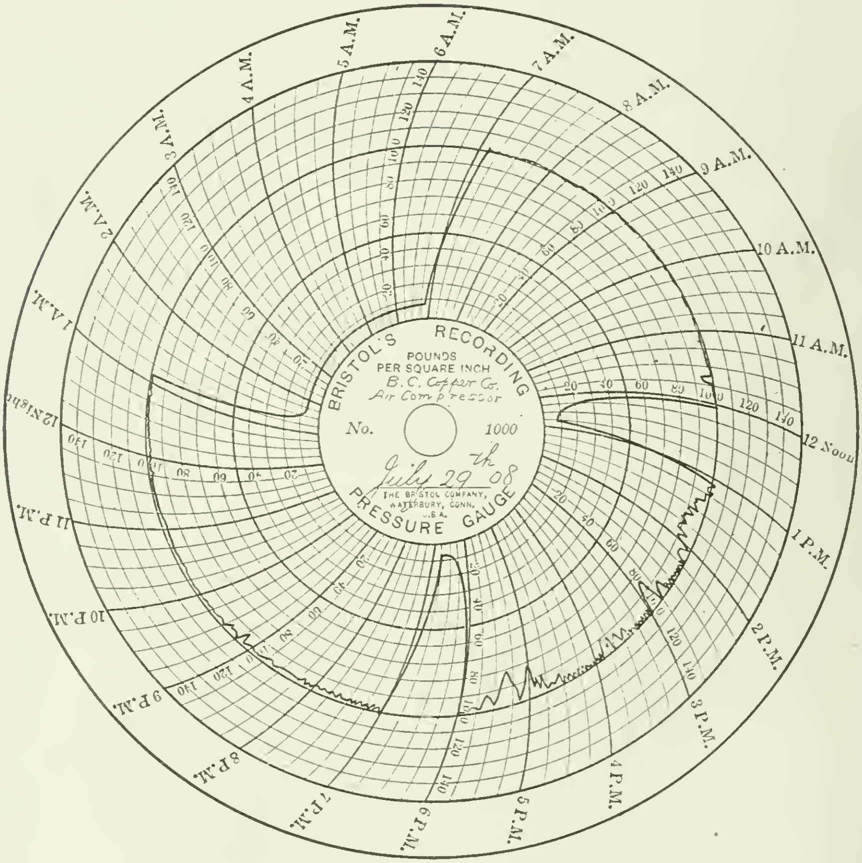


FIG. 6. PRESSURE-GAGE RECORD FOR VARIABLE-VOLUME AIR COMPRESSOR

It is hardly necessary to point out that these cards show almost perfect valve action both when compressing and when running unloaded. Further evidence of the very complete unloading of the machine is shown by the fact that the starting current, required for the alternating motor which runs the machine, does not exceed the full-load current. The completeness of the unloading as well as the very small friction of the motor, rope drive and compressor is also shown by the fact that the machine will run six minutes after the current is cut off.

The action of the unloader in maintaining steady air pressure is shown by the recording-gage diagram, Fig. 6. It will be seen that the machine is shut down from noon to 1 p. m., from 6 to 7 p. m. and also from 1 a. m. to 7 a. m. From 1 p. m. to 6 p. m. the machine is often overloaded, probably on account of opening up an air pipe to blow away the smoke from blasting. Except when overloaded or shut down the pressure is maintained at 97 to 100 pounds; the maximum variation does not exceed three pounds.

CARNEGIE AND THE CHEMIST

When Andrew Carnegie was young in the steel business, a short time after the starting of his first plant in Pittsburg, he had an experience with iron ore which he never forgot. This is how he tells it:

I was offered some ore that sampled about the usual grade, so far as I was able to judge from appearances, and at a reduced price. I bought several thousand tons, a big order for those days. The second day after we commenced to run it the foreman came to the office and told me the new ore was of no account, that it did not flow and that the furnaces were so choked they would have to be dumped very soon, unless some remedy was found. Those fires were built to last two years and to dump them at this time would mean so heavy a loss as to practically put me out of business. A young chemist had called on me a few weeks before, and while I had not paid much attention to him I had kept his card. It occurred to me that he might possibly be of some help, though I confess I did not then see what chemistry had to do with the iron business. But I sent for him and he came at once. First he examined the new ore, then the old, that we had been running without difficulty, and finally he looked at the furnaces. To avoid delay he made a little test of the two ores right there. I had told him when he arrived that I felt sure the new ore was worthless and admitted my mistake in buying it. Of course I did this as I did not want him to think I was ignorant of the business. You can imagine my surprise, then, when at the conclusion of his test, he quietly informed us that the new ore was so good, we did not know how to run it. The fact was that the new ore contained twenty per cent. more iron than the old, and all that it was necessary to do was to add a proportionate increase of flux to bring about reduction.

"After this great help, I kept that chemist in mind and it was not long after the experience just mentioned that his scientific training proved of such practical help to me that I have no hesitation in declaring it was a chemist who gave me my first real start in the iron business. I was in the habit of going home from work by a path that led along the river's edge and past a big rolling mill. On the evening to which I refer I noticed a number of men coming out of the mill yard with wheelbarrow loads of black material that seemed to be in flakes. They were emptying this along the river bank and from the condition of the place it would seem that hundreds of tons of it had been thrown there. Curiosity prompted me to ask one of the men what the material might be. He told me that it was the scale that peeled off iron when it was rolled or beaten. Wanting to know something more concerning it, I pocketed a handful and, without any word of explanation sent it next day to my chemist for analysis. He reported it was *ninety per cent. pure iron.* This was a revelation! I had been buying ore that ran forty per cent. iron, and when I chanced on a lot that ran sixty it was so good that I did not know how to handle it, and all the while these rolling mills were throwing away mineral that contained double the amount of pure iron than did the ore for which I had been paying out money.

"It did not take me long to decide that I wanted all the iron scale that the rolling mills in that district threw away; so I started a young man out with orders to buy, in his own name, all the scale the mills had, and to get three year contracts from them for all they might produce during that time, at a dollar a ton. Of course the rolling mill people laughed, but they took the young man's money—and then proceeded to grow wiser for the next three years."

LIBELED CHEMICALS

Nobody has any great objection to chemists, and the study of chemistry is regarded with calm by most people; but there is a strong feeling against "chemicals." The point is raised by "The Lancet," which points out that the potent word conveys to many minds the idea of a substance that is objectionable, especially when it is associated with articles of drink, food, or clothing. "Preserved with chemicals," "colored with chemicals," "flavored with chemicals," "glossed with chemicals," are expressions used disparagingly. Injury to health or material is implied. But this use of the word comes of ignorance.

Of course, there are preservatives which are injurious to health. It is true, too, that the glaze of the tablecloth, napkin, shirt-front, or cuff is obtained in many instances at the expense of the material. Anilines, synthetic essences, bleaching powder, borax, and so forth are sufficiently accountable for such evils, and these things being "chemicals" have brought that word into general opprobrium.

But what objection is raised against the use of salt, because it is a "chemical?" And what else is it? If, again, the word "chemical" denotes an abhorrent substance, what justification can there be for the popularity of (for example) whisky and soda-water, a drink not objected to by many persons who do not like the idea of "chemicals?"

Soda-water is eminently a "chemical." It is merely a saturated solution of carbonic acid gas in water. The water may be of natural origin, but the gas is certainly not so. It is obtained in several ways, all of which are "chemical." The gas, for example, is obtained in some cases by burning coke; in others by acting on chalk or sodium carbonate with an acid. Even the whisky itself may be regarded as a chemical, since it is the product of distillation and consists chiefly of alcohol, which is a chemical substance. Soap, too, is a "chemical." So is cheese. It is simply the nitrogenous substance of milk separated by the addition of acid. Ink is a "chemical." Possibly we might manage to live without chemicals; but few of us would enjoy it.

Sea-waterproof cement, bearing the name of "Aegir," is a product of a cement works at Hemmoor, Germany, and it is claimed it can be used with economy and efficiency for works constructed in sea-water, tunnels, and other places, where ordinary portland cement will deteriorate. The raw materials used in its manufacture are: chalk containing 99½ to 100 per cent. of pure carbonate of lime; roasted quartz, very finely ground; and finely ground ferric oxide. The ferric oxide is obtained partly from bog-iron ore and from other purer iron ores. After the quartz and ferric oxide have been finely ground, all the three materials are worked together into a moist paste. After having been dried the mixture is burned to clinker in the ordinary way. In other words, it is a cement in which iron oxide replaces the alumina.

THE CONSULTING ENGINEER

What if it is customary to employ a consulting engineer in Europe, even for small installations? On this side of the pond it is not necessary. You know better than that. You employ an architect to draw up your building plans and specifications. You employ a doctor to tell you what is the matter with you when you are ill. You employ a lawyer to look after your legal affairs; but when it comes to engineering you attend to that yourself.

You have heard of this failure or that failure by this or that engineer, and therefore you are not going to risk a similar failure, but you are going to trust to luck, that kind providence which watches over the helpless, whatever the cause of their helplessness.

Did your attorney ever make a mistake at the bar and lose your case? Did you ever change doctors when yours failed to help you? Have you ever made any mistakes? Are engineers anything but human beings that they should be above making mistakes? And if this or that engineer does make a mistake is it a good reason to pass him by? Don't we all learn by the mistakes we or others make, unless we are fools? As a matter of fact isn't the man who has made a few mistakes the stronger for it if he has profited by them?

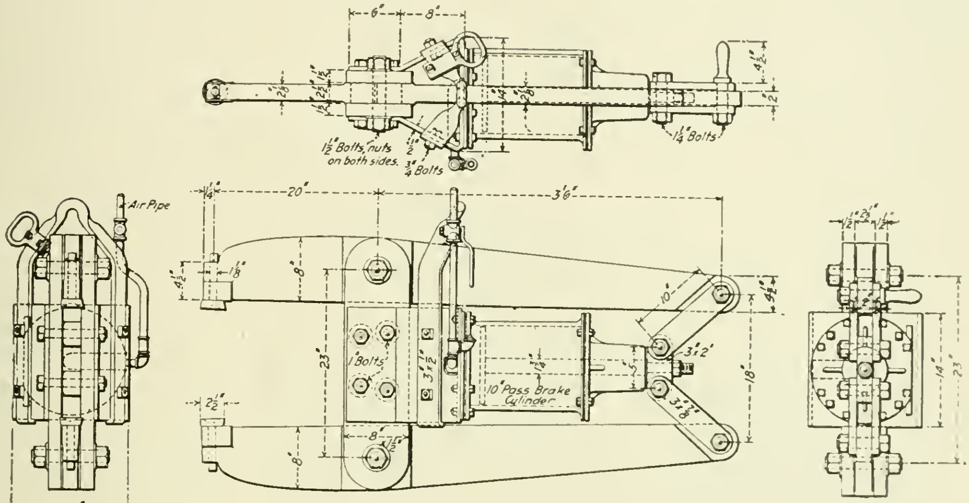
How can you tell whether you are getting a really good consulting engineer or not? Aye, there's the rub. Look up all of his work, if possible, and pick out one who has at least shown a disposition to make good his errors or failures, and remember no progressive man is without his enemies.—*Cold Storage and Ice Trade Journal.*

A COMPRESSED AIR SALVAGE FEAT

A record feat in marine salvage by compressed air is related by the chairman of the Liverpool Salvage Association. The steamer Veronese with a valuable cargo was sunk with a hole in her bow. The question was whether the old method of discharging the cargo and patching the vessel from the inside would have to be adopted or whether it could be avoided. It was decided to repair the damage under water, using pneumatic tools. Divers took the measure of the damage, and a steel patch was made on board the salvage steamer. Working on a platform twenty-eight feet below water, divers drilled the necessary holes in the ship. The plate was then sent down and fixed at once by patent bolts invented by the association's surveyor. The cargo was not disturbed, and the ship was brought back to Liverpool through the Bay of Biscay in variable weather, without starting a leak.

A HOME-MADE PNEUMATIC RIVETER

The cut herewith, adapted from the *Railroad Age Gazette,* shows a simple but efficient riveting machine built at the Detroit shops of the Michigan Central Railroad, and in constant use there. There are two heavy, normally vertical, steel straps, between which are pivoted the working levers, and to which is also securely fastened the operating air cylinder, taken from a standard air brake pump. In the act of riveting, compressed air admitted behind the piston drives it forward and the toggle links move both levers equally. There is no adjustment provided for in the machine itself, but to adapt it to various thicknesses of metal and lengths of rivets the adjustment is made in the lengths of the rivet sets, and thus it is made to work to varying thicknesses from 1 to 8½ in. It is used for all classes of work, but principally for riveting truck bolsters and the yokes to drawbars. It has strength and power enough to close rivets up to 1½ in. diameter, and is used for all the sizes below that. For the largest rivets mentioned an air pressure of 100 lbs. is required, but 50 to 60 lbs. is sufficient for the usual run of work.



HOME-MADE PNEUMATIC RIVETER.

The machine as used is suspended from a crane by a chain hoist, which will raise or lower it as required. It hangs over a rotatable table 16 in. high, and 2 ft. diameter, upon which the articles to be riveted are placed and moved around at will. While cheap and home-made as indicated, the arrangement is convenient and efficient and the cost of operation and maintenance is slight.

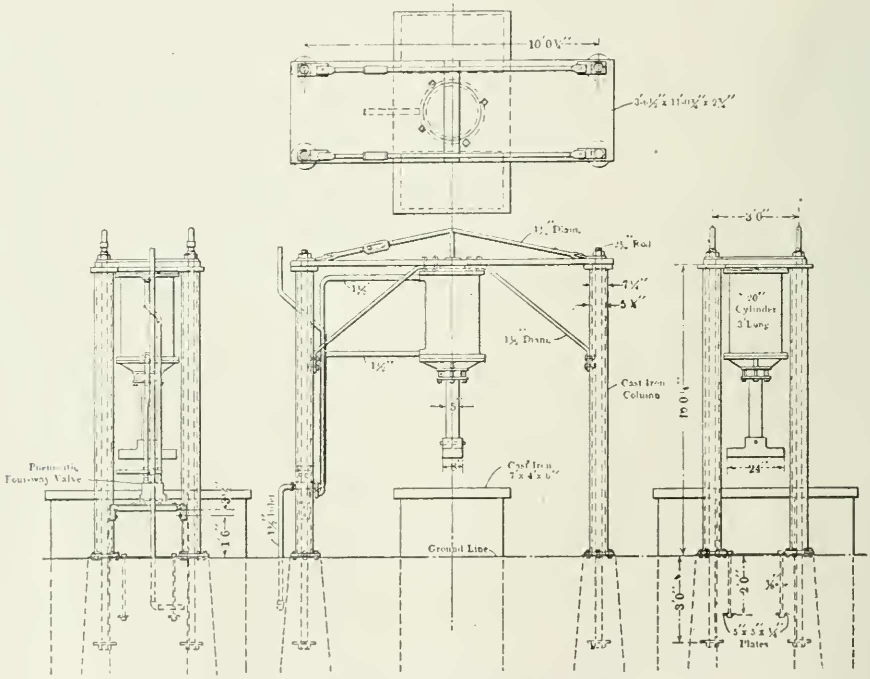
AN AIR CONDENSING PLANT

The following account is from Power and the Engineer. It will of course be understood that the condensation in this case was entirely for the purpose of reclaiming the water, to be used over again in the boilers, and not at all for the production of vacuum, so that there was no reduction of steam consumption and no increase in the power developed.

Some years ago in the oilfields of western Pennsylvania all wells were pumped by steam power, gas engines not being in general use at that time. In one particular locality the only water-pumping station was abandoned about this time as a nonpaying investment. As well water was unfit for boiler use, the use of the surface condenser and rainwater were the only means of obtaining the necessary water for operation.

The condenser was made of old 6-inch pipe that had outlived its usefulness in the oil wells. It was laid out on the ground in such a way that the water of condensation would drain back to a barrel sunk in the ground under the pump which was attached to the crosshead of the engine. The amount of pipe required depended on the size of engine and the load it was carrying. Usually 600 to 800 feet were sufficient for each 20-horse power engine.

The exhaust steam of the engines was expelled into this pipe, where it would be condensed and returned to the pump; in some instances the loss was so small that from six to ten barrels of makeup water was sufficient for 40 horsepower of engines each twenty-four hours. The makeup water was supplied from storage tanks in which was caught rainwater from the roofs.



LARGE PNEUMATIC STRAIGHTENING PRESS.

COAL IN NEW YORK

Nothing better illustrates the importance of New York city as a coal consumer than the voracity of the furnaces of the downtown sky-scrapers. One building consumes 100 tons of coal a day, another between 75 and 100 tons, and still another 50 tons per day. The erection of a new sky-scraper of the average size means that at least 200 more carloads of coal must be brought into the city annually. The anthracite consumed annually in New York, including that for tugs and railroads within the city limits, amounts to 9,000,000 tons. This is more than one-eighth of the entire marketable output. The consumption of bituminous coal has been estimated at 6,500,000 tons a year. The strictly retail trade of the city amounts, at the least estimate, to 7,000,000 tons, or nearly 2,000,000 tons more than are sold at retail in the cold northwestern States of North Dakota, South Dakota, and Minnesota combined. The retail coal business of the city is greater than that of any State in the Union, except, of course, New York State. Of the total retail trade of the 10 largest cities, New York contributes more than one-third of the business.

PNEUMATIC DEVICES IN CAR REPAIRING

The devices shown in the two cuts here reproduced from American Engineer and Railroad Journal, are in use in the freight car repair shops of the Pennsylvania Railroad at Altoona.

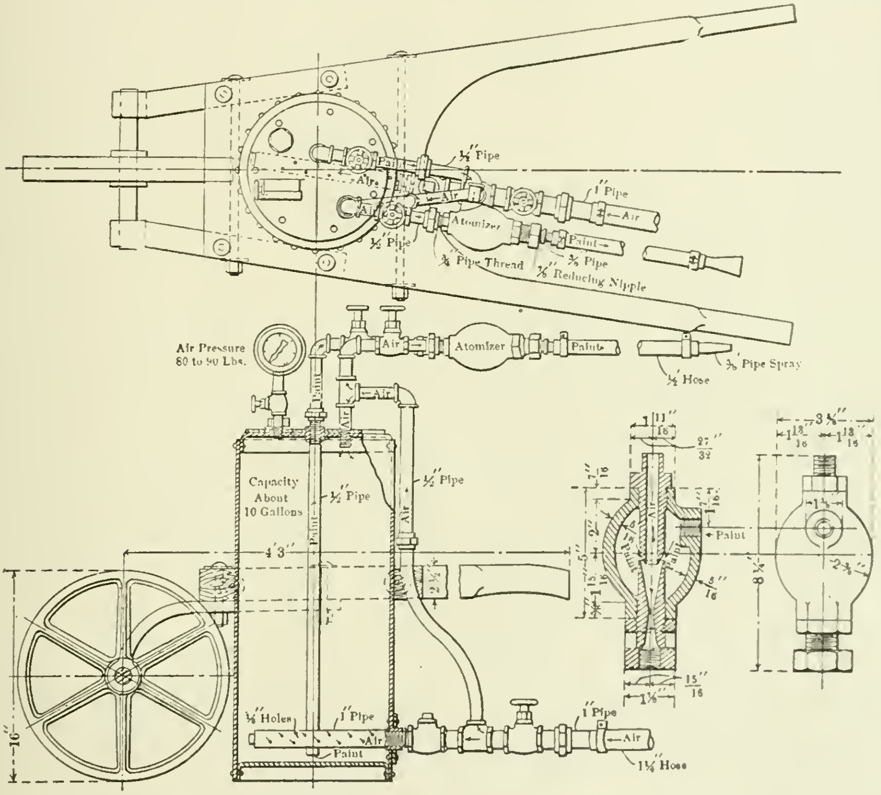
LARGE STRAIGHTENING PRESS.

The badly damaged steel parts are taken from the steel car shop, the freight shop and the west bound repair yard to the smith shop for straightening. This is done under a pneumatic press, which is shown in the cut. A frame-work supports the 20 in. air cylinder. Underneath the cylinder is a foundation upon which a cast iron table, 6 in. thick, 4 ft. wide and 7 ft. long, is placed. The air in the cylinder is controlled by a pneumatic four-way valve at one side of the frame work.

There are two of these presses just outside one end of the blacksmith shop. With the aid of a few cast iron blocks and two or three men to handle the sheets it is possible to straighten any part of the car and bring it back to its original shape. This work is done by piece work, the men being paid a certain rate per 100 pounds of material straightened. It is remarkable how adept the men become in doing this work. At one side of the press is a special oil furnace, with an opening 30 in. wide and 15 in. high, through which long material may be passed and any part of it heated locally. On the other side of the press is a large oil furnace for heating other parts. It has an opening 8 ft. wide and 21½ in. high at the center and is about 10 ft. deep.

PORTABLE CAR PAINTER.

When it is desired to paint a car complete it is taken to the freight car paint shop where the underframe and the body of the car are painted by the spraying machine shown in the cut. The principal feature of the machine is a paint tank having a capacity of about 10 gallons placed in a wheelbarrow frame work so that it can be moved about the shop. The arrangement of the apparatus and the details of the atomizer are shown clearly in the cut. The advantage of this type of spraying machine is that the atomizer is at the tank, and only one hose extends from it to the car. This machine works without waste. Very little surplus paint is found on the ground. Both labor and material are saved and better work is done. The paint is very uniformly distributed



PORTABLE PNEUMATIC PAINT SPRAYER.

FAST DRIVING ON THE RAND

The following is abstracted by Engineering and Mining Journal from issues of South African Mining Journal, Dec. 2, 1908, and Jan. 9, 1909.

The record on the Rand, South Africa, for driving with two machines made at the Van Dyk Proprietary mine, where an advance of 226 ft. was made in 26 days and nights, has been broken, and even the record speed for driving made at the Simmer Deep mine in April, where three machines were used, has been surpassed, for at the Van Dyk Proprietary mine a drift has been advanced in 62 shifts, 9½ hours long, 323 feet.

THE VAN DYK RECORD.

One white man and five Kafirs worked each shift, using two 3¼-in. Ingersoll-Sergeant drills. One round was drilled and blasted each shift. The following were footages for each measurement period (Sundays, of course, being excluded): Oct. 26-31, 12 shifts, 55 ft.; Nov. 2-6, 10 shifts, 50.5 ft.; Nov. 7 and 9-13, 12 shifts, 66.5 ft.; Nov. 14 and 16-20, 12 shifts, 68 ft.; Nov. 21 and 23, 28 and 30, 16 shifts, 83 ft.; total, 62 shifts, 323 ft. The average number of holes drilled per round was 12; the average advance per round was 5.209 ft.; the average number of pounds of gelatin used per foot was 8.513.

No bonus of any description was attached to the work either for white men or Kafirs, the Kafir being paid 1s. 7d. per shift. No special conditions were used to aid the work, and no endeavor was made to secure specially long rounds, as ordinary length steel was used. This performance is certainly remarkable.

COMPARISON WITH THE SIMMER DEEP PERFORMANCE.

It is interesting to contrast the details of this work with the figures for the Simmer Deep achievement. At that mine a drift was advanced 294 ft. in 61 consecutive shifts of 10 hours each. The size of the drive was 5x7 ft. One white man and six Chinese were employed on each shift, and they operated three Ingersoll-Sergeant drills on a bar. One round was drilled per shift, and the average footage per round was 4.82. The number of feet broken per case of gelatin consumed was 4.52; in other words, 11.06 lb. of gelatin were used per foot. Of the 61 rounds drilled, 59 had 14 holes each and two had 12 holes each. The air pressure at surface was 80 lb. per sq. in. It is interesting to note that special measures were taken to cool the drift after blasting and to eliminate dust. A water-pipe was connected with the air-pipe, so that the drive could be cooled, and the broken rock wetted without loss of time. After blasting the cut holes, water was forced by the air into the face, so that the contractor on returning to blast the round found the drive quite cool and free from dust.

Both these performances reflect the greatest credit not only on the miners, but also on the management and the Ingersoll-Sergeant drill. It should be taken into account that only two machines were employed at the Van Dyk, as against three in the Simmer Deep, and that the shifts worked at the former mine were half an hour shorter than those worked in the Simmer Deep.

FAST DRIVING AT THE VOGELSTRUIS CONSOLIDATED DEEP.

At the Vogelstruis Deep during November 1908, a drift was driven with two machines 272 ft. This was done by six white men and six Kafirs (both shifts). The drift was 6 ft. 6 in. in the clear above rails by 3 ft. 6 in. and 4 ft. 6 in. wide in the clear. This also is a notable performance, but it was surpassed in December when the same drift with two machines on a bar was advanced by six white men and six Kafirs 305 ft. in 31 days. Twelve holes were drilled to the round. The drift is at a depth of 3000 feet.

EUROPEAN WATER POWERS

A German engineer, Otto Mayr, has compiled a list of available European water powers, reaching a total of 34,157,600 h. p. Norway leads with 7,525,000 h. p. available, and 301,000, or 4 per cent., utilized; then follow Sweden with 6,750,000 available and 200,000, or 2.9 per cent. used; Italy, 5,500,000 available and 464,000 used; France, 5,524,000 available and 1,190,800 used; Austria, 5,125,000 available and 450,000 used; Germany, 1,677,600 available and 503,300, or 30 per cent., used; Switzerland, 1,500,000 available and 380,000 used. For the whole of Europe 10.41 per cent. of the available water power is used. Later records for Italy show 15.27 per cent. utilized, of which 89 per cent. was transformed into electrical energy and 11 per cent. was applied directly.

ELECTRIC AIR DRILL WORK—THE DRILL FOR CITY CONTRACTS

In New York city the rock drill is always in evidence. The city is built upon rock and where excavations are to be made for new buildings, drilling and blasting must be resorted to. The steam driven rock drill has been employed so long for this purpose that it is still very generally employed, just as there are still in the city at least a dozen lines of horse-cars.

The Electric Air drill has so completely demonstrated its economy, reliability, and convenience that those sufficiently informed must greatly wonder that it has not yet found employment in New York. The following timely and pertinent account of Electric Air drill performance was contributed to the columns of Engineering Contracting by Mr. W. L. McLaughlin, general manager of the Mogul Mining Company, Deadwood, South Dakota:

The electric air drill consists of an electric motor that runs an air pulsator, which furnishes air to the drill, which is mounted either on a tripod or column. The drill strikes a very powerful blow, and, for this reason, the bits are blunter or thicker to avoid breakage. The drill used by the Mogul Mining Co. was a No. 4D. For this type of machine a 4 H.P. motor is used. The drill cylinder is 4¾ ins. in diameter. The length of the stroke is 7 ins. The machine is adapted to drilling vertical holes to a depth of 10 ft. Its work will compare favorably with a 2¾ in. diameter steam or air drill.

During the month of June, 1908, the Mogul Mining Company used this drill for cross cutting work in their mine. During the month the drill was worked for 99 hrs. After the first 20 days work a new man was put to running the machine, with the result that for 3 or 4 days less work was done by the machine, but after that he was able to operate it at the average of the drilling record. In all, 555 lin. ft. of hole were drilled. This gives a rate of 5.6 lin. ft. per hour.

The cost of operating the drill was as follows:

1 miner, 99 hrs., at 50 cts	$49.50
1 helper, 99 hrs., at 25 cts	24.75
Total	$74.25

A miner and his helper operated the machine. This gives a cost of 13.4 cts. per lin. ft. The cost for the power used is almost negligible, Mr. McLaughlin states, and for the conditions in their mine this machine effects a great saving over the drill run by the ordinary air compressor. The rock drilled was quite hard, and considering the rates of wages paid, the cost is very reasonable.

The cost of maintaining the drill for the first 10 months was as follows:

New parts bought:

6 springs	$2.01
1 air gage	2.65
12 cup leathers	10.25
Fittings	12.25
Total	$17.31
Labor	39.00
Grand total	$56.31

For the first two months no repairs were made to the drill. The average monthly cost of repairs to the drill was $5.63. This makes a little over 1 ct. per lin. ft. of hole drilled during June, as a charge for drill maintenance. This is a low cost, especially when it is remembered that in comparing this cost with others, the cost of maintaining and repairing, the power plant needed for other style of drills, must be included.

City contractors always have an electric current available, and they should find the electric air drill especially adapted for drill purpose. It is still a common thing to find contractors for sewer and water pipe trenches doing tll their rock drilling by hand. There is scarcely any class of rock work that requires so many lineal feet of drill hole per cubic yard as narrow trench work, yet, in the face of this fact, hand labor is extensively employed by city contractors. The principal reason for this adherence to hand drilling is found in the fact that the installation of a power plant and pipe lines, followed by the frequent shifting of the plant along the street, runs up the cost of steam drilling in narrow trench work to a point that is frequently above the cost of hand drilling. Then, too, there is often a lack of room in the street for installing the steam boiler, etc.

It seems to the editors that a drill of the type described in this article is admirably adapted for rock trench work, for the electric current can be tapped at intervals and a long coil of insulated wire be used to feed the small motor of the air pulsator that operates the drill. There is no cumbersome power plant to install and shift, and, instead of a heavy pipe line, there is simply a light line of wire that conveys the current.

LARGE COMPRESSED AIR PLANS FOR SOUTH AFRICA

An arrangement has been made between the Victoria Falls Power Company and the promoters of the Harper power scheme, whereby the contracts for the supply of power to Eckstein mines secured by the latter are taken over by the "Falls" Company, which will erect another electric power station to meet the increased demand. The contracts to supply electric power to all the mines of the Eckstein Central Administration and Rand Mines, Ltd., groups involve the installation of plant of a capacity of approximately 84,000 kilowatts. (112,560 hp.)

THE COMPRESSED AIR SCHEME.

The most novel feature of the new scheme is the provision for central compressed air power generating stations. It is proposed to start with at least three of these: one will be situated at Brakpan, and will be steam-driven; another will be situated at the Simmer Deep, and a third at the Robinson Central Deep. The first will supply compressed air power to all the mines of the Far East Rand—the New Modderfontein, the Modder B, and, no doubt, the Brakpan itself. The second will supply the Germiston mines, and the third the mines of the Central Rand. Later, no doubt, other stations will be erected to cope with the increasing orders from mines about to start work, and possibly from some of the existing mines that have not yet considered making contracts. This compressed air plant will be in 8,000 h. p. units, consisting of 3,000 h. p. turbo-compressors for the first stage, compressing air to about 30 lbs. per sq. in., and reciprocating two-stage compressors for the second and third stages of 5,000 h. p. The plant will be driven by synchronous motors supplied with power from the chief power station.

The combination of turbo with reciprocating compressors overcomes the difficulties experienced in connection with the running of turbo-compressors in parallel. The turbo compressors used may be of either the Rateau or Zoelly type. The maker of the latter is the firm well-known in the engineering world as maker of turbines. Indeed, a turbine of the make in question is now employed in the Brakpan station.

MEASUREMENT OF AIR.

The compressed air supplied to the mines will be metered, with displacement or inferential meters. Both of these methods of measurement will be tried, and the more satisfactory one adopted. It is unnecessary here to draw the moral that with compressed air purchased by the unit, considerable economies can, and no doubt will, be effected in its use. The air mains will be welded by the oxygen-acetylene system.

AIR PRESSURE.

A noteworthy point in connection with the system is the fact that the air pressure delivered at the point furthest from the compressor will be guaranteed at a pressure of 100 lbs. per square inch. The high pressure is confidently anticipated to make for economy and efficiency. That so high a pressure increases the wear and tear of drills is, however, generally admitted; and the result is likely to be the gradual increase in the number of small light machine drills employed on the fields.—*South African Mining Journal.*

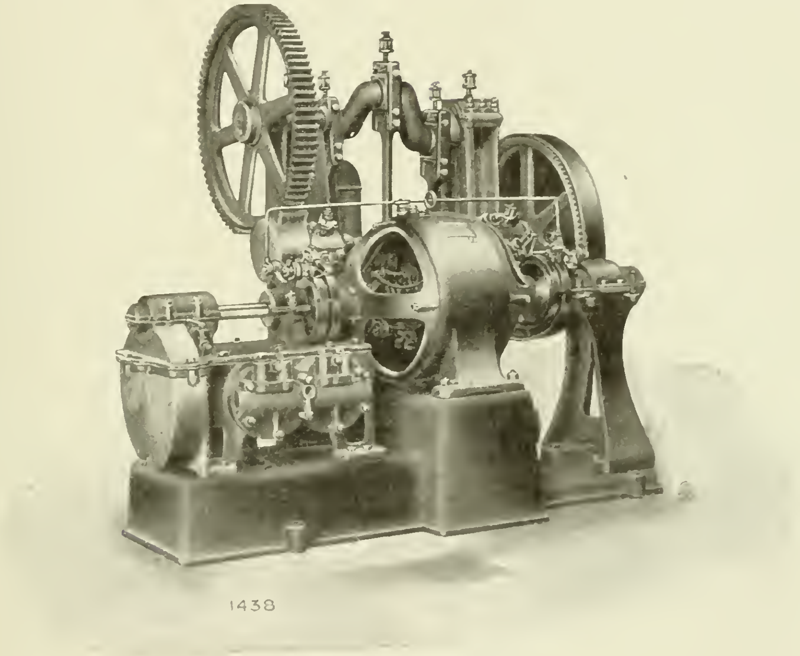
NITRIC ACID FROM THE AIR

The Badische nitric acid furnace consists of a long tube traversed from end to end by an electric arc discharge. Air is blown through this tube, being admitted tangentially so as to give it a whirling motion. This is found to raise the efficiency, no doubt by insuring that all portions of the air blown through shall come within the sphere of action of the arc. The entering air is systematically preheated by the outgoing reaction gases. Since the autumn of 1907 an experimental plant of 2,000 h. p. capacity has been in operation at Christianssand, Norway. This comprises three furnaces of 600 h. p. each. The length of the arc is no less than five metres (16½ feet). The life of the furnaces is said to be fairly long. The lower electrode is gradually moved up as it wears away. It is claimed as a special advantage of the system, that it gives a concentrated gas with a good yield and high power. Owing to the steady character of the arc, its prejudicial influence upon the power factor, especially marked with intermittent arcs, can be reduced to a minimum. As compared with the principal forms of furnace designed by other inventors, the Badische apparatus is distinguished by great simplicity, the absence of moving parts and of electromagnets. A plant is in course of erection by the Badische Company at the Rukwan Falls. This is planned in the first instance on a scale of 120,000 h. p., with the project of enlarging it to double this capacity in the future.

We are inclined to doubt if anybody can say whether a new project is overcapitalized or not; the test is operation. If the Humdrum Valley Railway, facing competition, either of carriers or of markets, real or potential, is able to pay its charges, and to earn five per cent. on its stock, we maintain stoutly that it is not overcapitalized, and the simplicity of this method of calculation lies in the fact that we do not know, nor want to know, how much it cost to build the road, what the replacement value is, or how much stock is outstanding.—*Railroad Age Gazette.*

COMBINED AIR COMPRESSOR AND WATER PUMP

The half tone shows a combined electrically driven air compressor and water pump used extensively in connection with automatic sprinkler systems, water supplies for buildings where an elevated tank is dispensed with, and for hydraulic elevator service. The combination is especially notable for its compactness, showing an important saving in floor space and foundations. The compressor, a pump of standard make and a driving motor, are all mounted upon a common sub-base. The pump and compressor are operated independently of each other, the change from one to the other being readily effected by throwing a switch, this single switch operating electric clutches for both. The motor is of the direct current, shunt motor type, designed and built especially for this service. It operates at low temperature and will stand heavy and continuous service. The apparatus is approved by the Board of Underwriters and is recommended by their engineers. It is built in several sizes, for water pressures up to 150 lbs., and 90 lbs. air pressure, by the National Brake & Electric Company, Milwaukee.



AIR COMPRESSOR AND PUMP.

MECHANICAL IMITATION OF GRAVITATION–NEGATIVE GRAVITY

Prof. Arthur Korn, according to an account in the *Westminster Gazette,* is said to have a machine which imitates the action of gravital force and apparently demonstrates that gravitation is a mode of motion.

It is assumed that gravitation is the result of the vibration of elastic bodies in an inelastic medium. The machine spoken of is simple. A metallic globe, fitted with a window for observation, is united by tubes with a cylinder, one end of which is closed by a membrane and to this membrane is attached an electro-motor, which, by alternately pushing and pulling the membrane, makes rapid pulsations. The metal globe contains two air-filled india-rubber balls of different sizes. The larger one is fixed firmly to the inside wall of the globe; the smaller is free to move whither it likes. The whole apparatus is then filled with water, and the motor set to work. Each time the membrane is pressed in, the increased water pressure causes the rubber balls to contract, and each time the membrane returns to its original position the relaxed pressure of the water causes the two balls to expand. The motor is set working so quickly that these pulsations become inconceivably rapid vibrations, and the contraction and expansion of the balls is invisible to the eye. As water is practically incompressible, Prof. Korn thus obtains the conditions he needs—he has two elastic bodies vibrating in an inelastic medium. Then the phenomenon looked for occurs. When the vibrations attain a certain speed, the smaller ball, impelled by a mysterious force, begins slowly to move through the water to the larger ball, and gradually increases its speed, exactly as the apple observed by Newton increased its speed as it fell nearer and nearer to the ground.

So far, this was merely a puzzling phenomenon; but that it was gravitation, and no other force, which drew the balls together was soon proved. Measurements showed that the bigger ball attracted the smaller exactly in accordance with Newton's law, or in inverse ratio to the square of the distances between them. It became, therefore, possible to construct an exact working model of the solar system in water, in which the planets should all move in their appointed paths without any visible support or externally-applied power.

Prof. Korn's researches do not end here. He had shown why matter attracts matter, but he had to solve the problem why matter also repels matter. Why is it, for instance, that comets, after rushing directly towards the sun from the depths of infinite space, never collide with it, and invariably return whence they came? To this problem the professor again applies the musical-vibration theory. Just as there are over-tones in the violin string, so in the vibrations of matter there are over-vibrations. These over-vibrations come into play when the attracted bodies come too near, and their effect is immediately repulsive. They are counter-gravitational in their effect, and operate in this way also only in an inelastic medium like water. In an elastic medium the vibrations of matter would have no attractive or repulsive effect; hence it follows that gravitation depends entirely upon the fact that all the heavenly bodies are surrounded by inelastic ether.

The results which Prof. Korn produces are of course incontrovertible, but his assumptions and deductions may still be questioned. The inelastic ether would seem to be especially difficult of acceptance, however much Prof. Korn may require it.

WEALTH IN WASTE

A more striking instance of the value of the utilization of a hitherto waste product would be difficult to find than that of the Tennessee Copper Co., which, in order to develop some system for preventing the destruction of vegetation by the sulphur fumes generated in its copper smelting plant, has developed a great sulphuric acid industry.

When the State of Georgia undertook to compel the Tennessee Copper Co. to prevent the injury to the vegetation of the surrounding country from the sulphur fumes, the decision of the courts was in favor of the State, but it was suggested that time should be given to the company to develop some system for preventing the injury of which the State had complained. Out of this grew a system or process for the making of sulphuric acid from gases of its smelting furnaces, giving to the Tennessee Copper Co. an estimated output of about 300,000 tons of acid per year. The marketing of so large an output was for a while a problem, but out of this condition there developed a situation which has now resulted in the organization of the Independent Fertilizer Co., with a capitalization of $75,000,000. This company, in addition to buying the output of sulphuric acid from the plant of the Tennessee Copper Co., has also purchased a large number of independent fertilizer plants, and will build a number of others.

Another company operating in the same copper field as the Tennessee is likewise preparing for the manufacture of sulphuric acid. Thus out of that which had not only been a waste product, but an absolutely injurious product, chemical skill, backed by great capital, has created a new industry, which will result not only in the investment of many millions of dollars in the development of copper mining and acid manufacturing as a by-product, but will also result in the building of new fertilizer factories and the reduction in the cost of fertilizers to Southern farmers.

This is one of the most interesting events in recent metallurgical history, fraught with very great advantages to many lines of industry in the South.

THE EVERLASTING INVENTOR

By W. H. Booth.

Most inventors lack that sense of proportion which helps a man to keep himself from looking the ass so many of us really are. The same inventions are constantly coming up to the top, but there is a new inventor and a new set of promoters, a new man with a fur coat. I wouldn't give a red cent for any invention unless at least one man, in the miscellaneous crowd that attends at the demonstration, wears a fur coat, or at least has fur collar and cuffs to his overcoat. He adds that one touch that makes the inventor so sure he has fallen among honorable city financial men of standing. At one time it is a rotary engine. Now, of late years, there has sprung up a new development of rotary engines. None of your common racheting quick-sliding steam-trapping sliding-door abutment valves, but genuinely artful and ingenious mechanical motions which get behind the steam and make it labor expansively for the benefit of the promoter. Some of them are really most ingenious, and within limits there are now rotary engines that will work very well. And the hopeful inventor measures up his little 10-horse buzzer, length, breadth and height, and in a few minutes he has shown you that put into the "Mauretania" it would knock spots off the present steam plant very completely.

Most of the men connected with these affairs are busy buying reports from consultants, for blocks of shares and promises. They come to me often enough with little things that are good enough as little things, but all of them want reports saying that the little thing only needs multiplying by 10,000 and it will drive the "Lusitania." A tear comes into their eye when I give them a report of facts and warn them that Lucy is not for them.

Then there is the steam boiler which, "by a peculiar adaptation of a well known but little recognized law to the evaporation of certain liquids has disclosed unsuspected merits in a quite novel cycle of operations from which great results may confidently be anticipated." At least, this sentence explains the sort of impression that is left on my mind by reading some of the prospectuses. It makes me think of hiring myself out to some honorable promoter as a writer of prospectus catch sentences. Why should such a gift of language lie fallow? I think it a beautiful sentence. As a rule if one succumbs to the temptation to go and see the wonderful invention at work there is much to be learned.—*Power and the Engineer.*

THE RUEPING PROCESS FOR CREOSOTING TIMBER

In this process the seasoned wood is subjected to treatment, for from half an hour to one hour, of an air pressure of from 60 to 75 pounds (depending upon the wood), so that all cells will be filled with compressed air. Without reducing this pressure in the impregnation cylinder, the warm impregnating fluid, which is usually creosote (on account of its great antiseptic qualities) is then forced from the pressure cylinders or tar reservoir into the impregnating cylinder by means of a somewhat higher pressure, or by gravity when the pressure is kept the same in the reservoir as in the cylinders.

When the impregnating cylinder is full and the wood is immersed, the pressure pumps are started and the fluid is forced into the wood under pressure, rising gradually from 60 or 75 pounds to 150 or 250 pounds, depending on the nature of the wood under treatment. Under the increased pressure the fluid penetrates into all the cells of the wood, soaking or impregnating the cell walls, and compressing still more the air formerly put in at 60 to 75 pounds pressure.

When the wood is sufficiently impregnated with the fluid (the quantity being usually specified in pounds per cubic foot), the expansive energy of the air in the cells forces as much of the impregnating fluid out of the wood as does not adhere to the cell walls. This excess is allowed to flow from the impregnation cylinders back and into the creosote tank.

Therefore, the distinctive feature of the process lies in the fact that no more fluid remains in the wood than is necessary for impregnating, coating or saturating the cell walls. Therein is the commercial advantage of this process.

From comparison with the customary creosoting process of impregnation, it is claimed that in the Rueping process 4 to 5 pounds of creosote per cubic foot will give a more uniform distribution of fluid than 10 to 12 pounds applied in the old way. Taking the average hewn soft pine ties at 3 cubic feet each, there will be a saving of about 20 pounds of creosote per tie.—*Industrial Progress.*

FRESH AIR

Few people have any idea how little impurity it takes to seriously affect the efficiency of the atmosphere. There is normally .04 per cent. carbon-dioxide in the air. If this part is increased to 3 per cent. lights will not burn.

Just think! Only 3 per cent. impurity (reducing oxygen from 20 per cent. to 17 per cent.) makes the air totally useless for combustion and absolutely unfit for continued respiration. This knowledge is fertile in hints for the betterment of many conditions. It is, of course, obvious that greater care should be exercised in ventilating all places where men work. But we knew this before. Bad air is a thing which requires no chemist to prove. No one knows better the evil effects of bad air than one who has worked in it.

What has not been so well understood is that more care should be exercised in providing good air for boilers or other combustion apparatus. Rarely is any thought given to the quality of air given a furnace. Too often the air draft draws air from the floor of the boiler room, which in turn opens off a room crowded with workmen. The air from such a source must be heavily charged with carbon-dioxide, moisture and other impurities, and it is no wonder that the fireman often complains that the coal burns badly. True, it is better that this foul air be drawn away from the workmen than that the boiler should burn well; but the scientific thing to do would be to ventilate the workroom and also to furnish good, fresh air to the boiler.—*Mining Science.*

FREE WATER IN THE EARTH'S CRUST

In the United States geological survey Water-Supply Paper 160, M. L. Fuller considers the subject of the total free water in rocks of various types. "Free water" is defined as the water that occupies the joints, solution passages, pores, or other openings in the rock, as distinguished from the chemically combined water in the minerals of the rocks. The free water has a more or less definite circulation even in the densest rocks, while the water in combination is not in liquid form, but is a part of the mineral compound itself. The free water should also be distinguished from the available water, for some materials, like clay, hold great quantities of water and yet give up only insignificant amounts. It is, in fact, possible for a rock to hold from 35 to 40 per cent. of water and yet yield almost none at all to a pump—that is, almost none of its water is available.

Mr. Fuller concludes, after consideration of all the available factors, that the total free water held in the earth's crust would be equivalent to "a uniform sheet over the entire surface with a depth of a little less than 100 feet (96 feet). * * * If the average depth of the ocean is 14,000 feet, its volume is equivalent to a layer 10,500 feet deep over the whole earth's surface. The underground water would therefore be roughly only one-hundredth of the volume of the ocean." This proportion has been computed by other investigators to be from one-half to one-eighteenth.

Mr. Fuller says: "There is a general tendency to overestimate the amount of water in the ground owing to the impression of great volume which a large well conveys, the fact that a large area is drained being frequently overlooked. A study of the conditions in deep wells in the United States leads the writer to believe that the average amount of water present in the earth is probably under rather than over the amount estimated.

THE LEAK WAS AT THE OTHER END

In the plant where I am employed we have a small belt-driven air compressor, supplying air at 80 pounds pressure to molding machines. The capacity of the compressor is about 35 cubic feet per minute. It has an automatic governing device which holds the pressure at any predetermined point within its capacity.

While on my vacation this machine refused to deliver the quantity of air needed and no amount of coaxing on the part of my assistant, who was in charge, would get it to do so. A machinist was called in, who stripped the machine and on using his calipers found the cylinder to be out of round about 0.005 or 0.006 of an inch. This he claimed was the cause of the trouble, and wanted the cylinder bored and a new piston fitted.

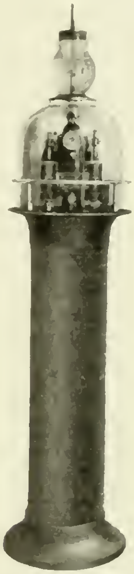
Upon my return a few days later I overhauled the machine, but could find no reason for the failure to do the work, as the cylinder, piston and rings were in good condition. I concluded that air was being wasted somewhere about the plant, and looked for leaks for several days. At times the pressure would go to 65 or 70 pounds and at others down to 25 pounds. Finally a search resulted in locating the trouble. It was in a beautifully arranged ventilating system using a sort of spray jet, having a head with nine 1/16-inch holes and was supplied by a ⅜-inch pipe with a valve to regulate the amount of draft. This device was not used all the time, which accounts for the fact that at times we could get our air pressure about up to normal.

The ventilating scheme was put in without my knowledge, or I should have known that it was the cause of the many hard names I had to stand for from the foundry foreman. The moral I have learned is, in case of failure of supply from no visible cause look for leaks. Also look for the inventive chap with a club. —*Power and the Engineer.*

A SMALL AUTOMATIC ELECTRIC AIR COMPRESSOR

There seems to be a vast field of employment for a small, always ready, entirely automatic air compressor working at a comparatively lower pressure, say not to exceed 30 lbs. gage. It is wanted by physicians and dentists, in hospitals and barber shops, by artists and photographers for air brushes, to supply air blast for brazing and soldering, for inflating pneumatic tires, for drawing oils and acids, and, last but far from least, for cafes and saloons for drawing and preserving beer and ale.

The air compressor shown in the half tone very completely fills these various requirements. The column of the machine forms an ample air receiver, and the complete machine is furnished ready for immediate operation, requiring only to be connected to the electric circuit and to the air distributing pipes if such are required. The compressor is direct connected to the motor which runs at 325 R. P. M. All the working parts are enclosed in a strong glass globe, on top of which is a glass jar containing water through which the air is drawn, removing dust and other impurities.



AUTOMATIC ELECTRIC COMPRESSOR.

The automatic cut-out so regulates the operation that the compressor runs only when the air is required to maintain the pressure in the tank, and the work stops automatically when the predetermined pressure, 14, 25 or up to 40 lbs. is reached as may be desired. A run of about one minute will raise the pressure in the tank from 15 to 20 lbs. Each machine has a 6 c. p. red electric lamp which lights up when the motor runs, making a novel and attractive feature. The compressor is built by the Norwig Manufacturing Company, Cincinnati.

ICE TO PREVENT FREEZING

A government expert has devised a novel method of keeping a car or compartment comparatively warm in zero weather; not by fire, but by the utilization of ice. A well-insulated car is fitted at each end with four galvanized iron cylinders reaching from the floor to the top of the car. In summer these cylinders are filled with ice and salt to keep the car cool. In winter they are filled with ice to keep the contents of the car from freezing. Ice is normally at a temperature of thirty-two degrees Fahrenheit, and changes temperature reluctantly, being a poor conductor of heat or cold. Consequently when zero weather prevails outside, the cylinders of relatively warm ice prevent the escape of heat; in other words, they maintain the temperature within the car. Another method whereby ice is employed for protection against cold consists in throwing a plentiful stream of water on the car when the temperature is near zero, which freezes at once and forms a complete coat over the car. The action of this ice is the same as in the case of cylinders filled with ice. A similar plan is frequently adopted in the transportation of bananas, a fruit particularly susceptible to cold.

AN ENGLISH SAND BLAST TUMBLING BARREL

An interesting machine of this class is in successful operation in English foundries, and we are indebted to Engineering for the following description. The barrel is 27½ in. in diameter and 35½ in. long, placed horizontally in a casing and supported on two chain-driven rollers. The drive is through shaft and bevel gears and a second chain from a short shaft carrying fast and loose pulleys 23½ ins. in diameter and of 3½-in. face. The interior of the barrel is fitted with a spiral conveyor, and the castings are carried by this along the drum, being fed in on one side through a hopper and discharged from the other through a door. The air for the blast is led into two nozzles fitted with chilled-iron nose-pieces, which are easily renewable. The sand escapes from the drum through perforations, falling into a trough, whence it runs down to a narrow pit. From this a spiral conveyor working in the trunk casing at the back of the machine carries the sand to a bucket elevator, which throws it into a chute leading back to the sand-blast apparatus. A hole is cut in the cover of the tumbler chamber for a connection with an exhaust fan, by which the fine dust is carried away. This machane will handle 1,100 lbs. of grey iron castings per hour. A large size, 35½ ins. in diameter and 43 ins. long, is provided with four nozzles, and will handle 1,800 lbs. of castings per hour. The air pressure, when sand is used, is 15 lbs. per sq. in., and 30 lbs. when iron grit is used. The small machine uses 70 cu. ft. of air per min. and the larger one 140 cu. ft.

HOW NOT TO THAW DYNAMITE

This season's batch of fatalities attending the thawing of dynamite seems, up to date, to be less than usual. The latest horror in this line comes in a dispatch from Glendive, Montana. With work almost completed, it says, the first real catastrophe in connection with the construction of the lower Yellowstone irrigation canal occurred when general foreman Jones Donaldson was killed and a laborer was fatally injured by an explosion of dynamite.

A fire had been started to thaw out 15 sticks of dynamite when one of the men called Donaldson's attention to the fact that some of the dynamite was burning. He ran to the spot to save as much of the dynamite as he could and was bending over it when the explosion took place. His face was blown away and one arm and one leg were torn off. The other man who was running to help Donaldson was only a few feet away. Flying rock broke his collar bone, penetrated a lung and inflicted abdominal injuries.

A LOCALIZED MINE EXPLOSION

An explosion, fortunately limited in action and effect, occurred recently in the Sewickley mine of the Keystone Coal & Coke Company at Madison, Pa. There was a bona fide explosion, but it was confined to two rooms where two men were killed, while the three hundred men distributed through the mine escaped. The detonation felt throughout the mine caused a rush to the surface, and fire bosses went into the mine and brought out the two bodies. Not a trace of gas was found, the bodies were not marked and each gave evidence of suffocation by fire damp. It was decided that the explosion was the result of the firing of a shot before the dust in a room had been allowed time enough to settle.

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W. L. SAUNDERS, - - - - - - Editor
FRANK RICHARDS, - - Managing Editor
L. I. WIGHTMAN, - - - Business Manager
H. L. KEELY, - - - - Circulation Manager

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NO TIME FOR A BUREAU OF MINES

Nearly a year ago the House of Representatives passed a bill creating a Bureau of Mines to be devoted to purposes of investigation and the dissemination of information of vital interest to one of the most important of our national industries. There was no proposition for federal inspection or any interference with state supervision. Of the necessity for such a bureau and for the increased safety and efficiency which it could be instrumental in securing there can be no question. While experts are all agreed that the natural conditions at our mines should make them the safest in the world, they are in fact just the reverse of this. During the past 19 years nearly 30,000 men have lost their lives in mine disasters, and a much greater number have been maimed and permanently disabled. The death rate has more than doubled since 1895. In 1906 the number of coal miners killed in France was less than .84 per thousand employed; in Belgium, less than .94; in Great Britain, 1.29; in Russia, 1.80; in the United States, 3.40 per thousand, and for the last three years our average has been much higher.

The bill passed by the House failed in the Senate "for want of time," and a new congress will have to begin again at the beginning. *Copper Age*, Butte, Montana, speaks of the situation as follows:

It is difficult for western mining men and coal miners of the east to understand why the senators should ask for so much time upon the question of a mining bureau. While United States senators are sitting back in comfort and ease and free from all danger, waiting for more time, miners are being killed by accident at the rate of more than three for every thousand employed during each year, and mining enterprises all over the country are not receiving just recognition at the hands of congress. If an explosion should occur in one of the cloak rooms, committee rooms or toilet rooms of the capitol building and kill, or even slightly injure, a member of the senate, there is not the least doubt but that all of the machinery of the government would be suspended if necessary to inquire into the accident and remedy the defect by providing against a recurrence of the explosion. But it is different if several hundred ordinary miners lose their lives in a mine. Little notice is taken of the occurrence and it does not even call the mining bureau bill from its peaceful slumbers in a senate pigeon hole.

SAFEGUARDING PENNSYLVANIA MINES

A new mining code, prepared by a commission appointed by Governor Stuart, is now before the Legislature of Pennsylvania and is being considered by the House Mines and Mining Committee to whom much interesting and important evidence is being presented. At a recent hearing Francis Feehan declared without qualification that the explosions in the Darr, Naomi and Marianna mines were due either to the use of electrical machinery or "open lamps," and he urged that the bill be amended so as to prohibit the use of electrical machinery or the open or naked lights which, under certain restrictions, are permitted by the pending measure. The assertion of President Feehan that the five hundred men killed in those disasters would be alive to-day had the State properly safeguarded them was not disputed.

Speaker Cox inquired if there had been more explosions since the installation of electrical machinery. Mr. Feehan said that the number of explosions had greatly increased, and that the fact that electrical apparatus is a menace to life is shown by the proposed action of the mine owners of Great Britain to discontinue the use of such machinery.

BILL FOR CAISSION WORKERS

A proposed amendment to the labor law of the State of New York and now before the legislature relates to the employment of men in caissons, tunnels and other places where compressed air is used. The bill provides that no employe is to be permitted to work in any place where the pressure exceeds 50 lbs. to the square inch. Medical officers must be in attendance at all times; employes must be examined before being permitted to work, and reëxaminations will be provided for; persons addicted to the excessive use of intoxicants to be prohibited from engaging in the work; persons who have never worked in compressed air are to work only half the periods prescribed for others, and hot and cold water baths and dressing rooms must be provided.

PROBABLE CAUSE OF AIR COMPRESSOR EXPLOSIONS

The following correspondence completely explains itself:

Editor of *Power and the Engineer*:

On one occasion I had to look for the cause of two air-compressor explosions. The air was compressed to 17 pounds per square inch. In both cases the pipes were ruptured. Various theories were investigated, such as simple failure of the pipe, oil spray in the pipe, oil ignition at the extreme end, poor grade of oil, leaky discharge valves. The last-named offered the most plausible explanation, as air which had been compressed evidently leaked back into the cylinder where it became recompressed. This recompression will make it hotter and hotter until it either reaches a point where radiation will take the heat faster than the temperature can rise, or the temperature will rise until the oil catches fire. The best of oils will take fire if heated enough.

F. W. HOLLMANN.

Baltimore, Md.

Editor of *Power and the Engineer*:

I note in your columns a letter from F. W. Hollmann under the title, "Probable Cause of Air Compressor Explosions," in which he suggests leaky discharge valves as the "most plausible" explanation of the cause of certain destructive compressed-air pipe explosions. As far as my knowledge extends, the letter does not suggest even a *possible* cause of such explosions.

The letter says: "Air which had been compressed evidently leaked back into the cylinder, where it became recompressed. This recompression will make it hotter and hotter until it either reaches a point where radiation will take the heat faster than the temperature can rise, or the temperature will rise until the oil catches fire."

In the case under consideration the air was compressed to 17 pounds gage and, with an initial temperature of 60 degrees Fahrenheit, the temperature after compression would be 190 degrees. If the air at this temperature could be recompressed, the final temperature would then be much higher, and if this operation could be repeated many times, the theoretical temperature attained might go as high as the most unbridled imagination could carry it; but no such result could come from leaky discharge valves.

The discharge valves would have to be in very bad condition to leak back 5 per cent. of the air compressed per stroke, and this return leakage into the compressor cylinder would occur during the intake stroke, continuing perhaps, if the leakage was very bad, during a small portion of the compression stroke; not far, because with adiabatic compression, full pressure would be reached when the piston reached the middle. When the piston starts for the intake stroke the air in the clearance space, heated by compression, must first re-expand down to atmospheric pressure and, coincidently with its re-expansion, its temperature will fall entirely back to what it was before the compression began. The air leaking back through the discharge valves also re-expands and its temperature falls correspondingly and, mingling with the incoming air at atmospheric pressure and temperature, the temperature of the whole cannot be raised appreciably by the leakage. This air which has leaked back becomes an inseparable part of the cylinderful, and when the mass is compressed and discharged it is carried along together and no portion of it can be isolated and worked back and forth, as assumed, to have its temperature cumulatively augmented.

These attempts to solve the mysteries which still seem to be connected with some of the explosions that occur in connection with compressed air are certainly not to be discouraged. It would seem that the oil rather than the air is the thing to be studied. It is a noticeable thing that the initial explosions seem to occur more frequently in the pipes after the air has left the compressor rather than in the compressor cylinder head, where the temperature may be assumed to be the highest.

Compressed air alone, no matter how hot it may be, cannot possibly explode. The explosion is, of course, due to the ignition of a mixture of air and a volatile constituent of the lubricating oil. This volatile ingredient being present in sufficient quantity, there must still be provided time and opportunity for the mixing to be completed. This operation goes on rapidly, so that the conditions may be ripe for the catastrophe very close to the compressor. With the mixture ready for the explosion, ignition may occur spontaneously if the temperature is sufficient or a spark may be produced by friction and cause the explosion at a lower temperature.

Oil often burns bodily in the compressor cylinder heads and in the receiver without any explosion, receivers and contiguous piping sometimes becoming red hot. This might be going on in some case and provide the means of firing the explosive mixture which might be formed farther along in the pipes.

The obvious deduction is that we should use oils from which the more readily volatile constituents have been distilled, that we should use as little as possible of even the best oil and that, wherever there is a possibility of the used oil accumulating, provision should be made, and availed of, for frequent draining.

FRANK RICHARDS.

New York City.

CEMENT HELPS A CRACKED AIR CYLINDER

Editor Compressed Air.

In Compressed Air Magazine, Feb. 1909, page 5181, I notice "Concrete and a Broken Air Chamber." At Ryhope Collieries, where we are at present installing new compressors, in January of this year the old compressor developed a crack longitudinally in one of the air cylinders, the working pressure being 50 lbs. The water jacket was emptied and filled up with neat cement, a small spray of water being injected into the cylinder. In the meantime a new air cylinder was ordered, and the old one worked four weeks in this way until they were able to renew it. This I think is as good a temporary repair as the one quoted.

London, E. C. E. GRAHAM.

A BANNER YEAR FOR AMERICAN SHIP BUILDING

United States Shipping Commissioner, E. T. Chamberlain, reports that for the year ending June 30, 1908, the total number of vessels built in the United States was 1,457, with a gross tonnage of 614,216. For an approach to this record we have to go back to 1855 which had a total gross product of 583,450 gross tons. The total documented shipping of the United States at the date cited above was 25,425 vessels with a gross tonnage of 7,365,445 which is the largest in our history and larger than the tonnage under any other flag except the British, 11,503 vessels of 18,700,537 tons. Over one-third of our merchant tonnage is on the Great Lakes and the great bulk of the remainder is employed in domestic transportation

AN OVERLOADING PARADOX

In an account, on another page, of the record cards of an automatically unloading air compressor, the compressor is said for a certain portion of the day to have been overloaded, as evidenced by the descent of the delivery pressure line at that time. What really was happening was that the air was being used or taken from the pipes faster than the compressor delivered it, so that the normal delivery pressure was not maintained. As the compressor was belt driven, and consequently operated at constant speed, the lowering of the delivery pressure involved also a lowering of the mean effective pressure for each stroke, and a corresponding reduction of the horse power consumed; and yet we are in doubt whether it was incorrect to say that the compressor was overloaded, and we are at a loss for a single word which would state the case more correctly. In the case of a horse, to take a part of the load from his back, would be a strange way to overload him.

NEW BOOKS

General Lectures on Electrical Engineering, by Charles Proteus Steinmetz, A. M., Ph. D., Robson & Adee, Schenectady. 284 pages, 6¼ x9¼ inches. Portrait of author in colors, numerous diagrams, no index. $2.00 net.

These seventeen lectures by Professor Steinmetz were originally delivered under the auspices of Union University in the winter of 1907-8 to a class of young engineers. They are so simple and intelligible, avoiding the use of mathematics entirely, that they are available to a large class of engineers who are engrossed in practical work. A broad review is given of the entire field of electric power generation, transmission, distribution, control and use, showing the close relation and interdependence of all the factors of the problem, and there seems to be not a waste word in the entire book.

TRADE PUBLICATIONS

Dubois Gas Engines and Producer Gas Plants, Dubois Iron Works, Dubois, Pa., 36 pages 6x9 inches. The engines built by this firm, also the gas producers, are here described and illustrated in detail with discussion of their practical operation. At the end are given practical costs of installing and operating both a steam and a producer gas plant of 200 h. p., with the result that while for the first year the steam plant would show a saving of $1,800 in first cost the gas plant would show for that year and for every year subsequent a saving in operating expense of $3,736.

Aids to Shippers, Oelrich & Co., Bowling Green Building, New York, 62 pages, 7x9 inches, stiff covers. This book is true to its title all through, containing various information principally for foreign shippers, with tables of money, weights and measures, shipping and custom regulations, classifications of goods, freight rates, etc. New and special information is given concerning automobile shipments. Sent postpaid on request.

Air Compressors for Industrial Service, Publication No. 386, National Brake and Electric Co., Milwaukee, 24 pages, 6x9 inches. The compressors shown are all electric driven, some combining compressor and pump, many of portable type.

Buffalo Blacksmith Tools, Catalogue 78B, Buffalo Forge Co., Buffalo, N. Y., 56 pages and cover, 6¾x10 inches. Forges of all kinds shown also blowers, punches, shears, drills, etc.

Westinghouse Fan Motors, 1909, Westinghouse Electric & Manufacturing Company, Pittsburg, 36 pages, 7x10 inches. Artistically illustrated and beautifully printed, embodying full information in the line indicated. The lightly clad nymph in colors on the cover, sitting by a pond with an electric fan playing upon her extremities carries rather beyond the limit for coolness.

A STEEL PROTECTING PASTE

A cement paste for protecting steel from gaseous fumes has been used by the Pennsylvania railroad at Columbus, Ohio, with signal success. The coating is a cement paste mixed in the proportion of 12 lb. pure red lead, 32 lb. portland cement, 4 lb. linseed oil, and 2 lb. dryer. This mixture should make a paste like putty, but if too soft, cement and red lead are to be added, and if too heavy, oil and dryer are are to be added. The method of application is as follows: 1. The iron or steel surface to be coated should be as clean of rust and foreign matter as it can be made, using either sand-blast, steel brush, chisel, or sand-paper for this purpose, according to the amount and hardness of the foreign matter to be removed. 2. Apply one heavy coat of red lead and allow it to set. 3. Apply one heavy coat of Japan dryer. 4.

Apply paste on dryer while latter is green; do not allow Japan dryer to become dry before applying paste. The paste should be put on about one-eighth inch thick, rubbed with trowel and pressed around rivet heads and angle flanges by hand. 5. Cover all with one coat of red lead. This last coat adds a great deal to the life of the coating, as it retards the hardening effect of the atmosphere on the paste. The life of the coating is said to be six years, and the cost for labor and material, including the cleaning of the metal, eight cents per square foot.

DEMIJOHN WATERS

A "Spring Water" shipment was seized in Washington a few days ago by order of the Bureau of Chemistry of the Department of Agriculture, on the ground that it contained the colon bacillus. The Bureau of Chemistry is beginning an investigation of the bottled waters and soda fountain supplies in the District of Columbia, that is likely to furnish interesting results. The seizure recalls an investigation made a good many years ago by John W. Hill, of Cincinnati, which showed a very large number of bacteria in one of the favorite imported spring waters. It would be interesting to know how many analysts have made a similar discovery, for it is currently believed that a good many of these so-called spring waters so common in office buildings are really worse than the regular city supplies, although they may have less color. Some years ago the Massachusetts State Board of Health investigated a number of the springs of that commonwealth whence water was bottled, and its report is well worth consulting by those who are inclined to put their faith blindly in the alleged high quality of every kind of water that is peddled in a green demijohn.—*Engineering Record.*

GAS ENGINE DRIVEN GAS COMPRESSORS

The Mohican Oil & Gas Co., one of the large gas operators in the central Ohio district, is establishing a compressing station at Howard, Ohio. The initial equipment of this station will comprise two 1,000 H. P. direct acting two-stage compressors driven by Westinghouse horizontal, double-acting, twin-tandem gas engines. These machines will be of the same design as the standard gas engine which has been so successfully applied to power station work. These units are designed to operate on the varying suctions occurring at the wells from time to time, and to deliver at any desired pressure up to 300 lbs. They will, of course, operate on natural gas, using for this purpose a small percentage of the gas pumped for distribution.

THE RAILROAD SIDE OF IT

The Missouri River is in a better navigable condition to-day than it was when boats plied its entire navigable length of 2,285 miles; but no boats run there to-day for the simple reason that they cannot live and carry freight. This and similar reasons apply to the Mississippi and Ohio and their tributaries. The railroad comes to the people's doors; it carries them and their produce in the direction they want to go; it carries them 400 miles a day as against 50 to 100 by the river; it operates in winter as well as in summer; in the fall of the year when crops are harvested and freight is most abundant and transportation most needed, the railroad is in the best physical condition of the entire year while the rivers (through low water) are in the poorest; and finally the railroad carries so cheaply that the profit is taken out of the river business. The railroad satisfies the needs of the people better than do the rivers and it gets the business. In Europe railroads do not serve the people as well or as cheaply, while far greater attention is given to the development of waterways than here, and this fact and the greater density of population, are the true reasons why the inland waterways of Europe are used more than they are in this country.

NOTES

To find the contents of a cylindrical tank in gallons, multiply the square of the diameter in feet by half the length in inches. The result will be about 3 per cent. too low.

There is no finality in engineering, the solution of any one problem is the propounding of several new ones, and each is but another step in the unending march of progress.

There is a water power plant being erected in Norway with an installed capacity of about 400,000 kilowatts (536,000 h. p.) to be used solely for making nitrates from atmospheric nitrogen.

The average cost for supplying 1,000,000 gallons of water, based on the reports of twenty-two cities, was $92, this sum including operating expenses and interest on bonds.

It is understood that the shops of the western divisions of the Canadian Pacific Railway are to be located at Lethbridge, Atberta, on account of the supply of natural gas available for fuel. The shops will employ about 600 men to begin with.

More than a million official communications are handled annually by messengers between the collector's office and the appraiser's office in New York, and the Secretary of the Treasury has very properly asked Congress for an appropriation for a pneumatic tube system connecting the two offices.

To escape the payment of $35,000 bonds and $1,000 interest, Ulysses, the capitol of Grant County, Kansas, has been relocated a mile and a half outside its own city limits. Only a frame court house and a school building mark the spot where 20 years ago stood a prosperous village of 1,200 inhabitants.

The following is one "claim" of a patent recently issued to T. A. Edison:

1. The process of making very thin metallic flakes, which consists in subjecting metallic granules to successive rolling operations, and annealling the same in a gas which does not react thereupon, *between one* or more of the passes, substantially as set forth.

A decision of the Supreme Court of Oregon makes it impossible for any person or corporation to hold a water power or irrigation right for speculative purposes. Those persons, therefore, who have filed claims on water powers on any of the rivers must put the water to a beneficial use or forfeit the right to the first person who does so apply it.

The flat-wheel evil is known to everyone who rides in cars, but few realize the enormous energy developed by a flat spot in a car wheel. Professor Hancock, of Purdue University, finds that a flat spot 2½ inches long on a 33-inch wheel, carrying a load of 6,000 pounds at 30 miles per hour, will deliver a blow to the rail of more than a 1000 foot-pounds. The same flat wheel supporting a 55-ton interurban car running at 60 miles per hour, would deliver a blow with an energy of 9,500 foot-pounds. Such a flat spot would be produced by wearing off less than 0.05 inch of metal.

The destruction of water pipes by electrolysis at Winnipeg, Manitoba, is stirring the thoughts of engineers, property owners, city officers and street railway managers. The trouble has recently become more pronounced and heavy damage suits are threatened. In certain parts of the city it has been necessary to replace pipes as often as once a year.

It is estimated that in the Borough of Manhattan there are about 10,000 passenger elevators and 12,000 elevators for freight service. In twenty-six office buildings of eighteen stories and over, with a rentable area of 116 acres, there are 231 elevators, which travel between 4,000 and 5,000 miles of vertical distance each day, and carry 615,000 passengers. There are 8,000 elevators in office buildings alone.

The gangplank of the "Kaiserin Auguste Victoria," of the Hamburg-American line, slipped from its place during the discharge of cargo at Hamburg, Germany, Feb. 24. Thirty persons were dropped into the water and 14 of them were drowned. The work of rescue was hampered by ice in the water near the dock. Reports state that those killed were stewards and stewardesses of the ship and dock laborers.

Oxygen has become the almost universal remedy in cases of poisoning by gases—such as coal gas, acetylene, foul air from sewers, after-damp of mines, etc.—but its application is a difficult matter for the inexperienced bystander. A new apparatus by Dr. Brat made in Westphalia, is designed to clear the lungs and act more or less automatically in giving artificial respiration. The portable form consists of a fair-sized oxygen cylinder, a chest containing a small air pump, levers and other parts, and the usual face mask for the patient. When able to do so, the patient breathes the oxygen without help. If necessary, the attendant gives a rhythmical motion to the pump valve, and the liberated oxygen actuates the pump, withdrawing air from the lungs. Respiration is thus re-started or supported.

The grouting of cracks in foundations and walls should be done under pressure. This is accomplished by discharging the contents of a receiver filled with grout (which is a mixture of cement, fine sand, and water, of the consistence of cream) under air pressure. For this purpose an air pressure of from 80 to 100 lbs. per square inch should be used. The edge of the crack should be pointed up, and allowed to set before filling with grout.

The municipality of Plauen, Germany, following the example of Paris, has adopted a new regulation forbidding the use of natural ice in drinks, like beer or other beverages, because of the danger from impurities in such ice which might be inimical to health. In the cafes, hotels and public drinking places of the German town, however, only manufactured ice is permitted to be used in drinks, under penalty of 150 marks or imprisonment for not to exceed fourteen days.

In a discussion at the A. S. M. E. semi-annual meeting it was stated that strips of seven materials, mounted on a board and subjected to the uniform action of a sand blast for 45 minutes show the following relative abrasive-resisting qualities, rubber belting being taken as the standard: Rubber belt, 1; rolled-steel bar, 0.66; cast iron, 0.28; balata belt, including gum cover, 0.2; woven cotton belt, high grade, 0.16; stitched duck, high grade, 0.13; woven cotton belt, low grade, 0.06 to 0.11.

Cylinder oil in air compressors undergoes partial combustion to carbon monoxide, owing to the high temperature produced in the cylinder, which ranges from 350 to 450 degrees F. This gas, if produced in large quantities, so as to become mixed in the proportion of about 1 part of carbon monoxide to 2½ parts of air, is highly explosive. The gas is also poisonous, and the atmosphere in narrow working-places where air-drills are used, is sometimes rendered injurious from this cause. The remedy is to use a high-grade cylinder oil which is non-volatile and resistant to combustion at the temperature of the compressor cylinder.

The H. W. Johns-Manville Company, of New York, is introducing a chemical compound, called Leak-No, which resembles powdered iron, and when mixed with water and applied like putty to cracks, or other defects, in iron or steel articles, metallizes and becomes a permanent part of the article to which it is applied. When hard it much resembles iron in color. The manufacturers offer to refund the purchase price in case it fails to stop any ordinary leak in anything made of iron or steel against any pressure of oil, steam, gas, air, ammonia or water; and to stand any heat or chemicals that iron will stand, when applied according to directions.

Natural gas, being composed almost entirely of methane, or marsh gas, requires much more air than artificial gas to effect its complete combustion. Methane requires twice its volume of oxygen, while hydrogen and carbon monoxyde, the chief constituents of artificial gas, require only one-half their volume, so that roughly, about four times as much air is necessary for the complete combustion of natural gas as is required for artificial gas. The orifices of appliances for burning natural gas are smaller than those for artificial gas on account of the high pressure at which the former is carried.

In Europe a new composition, "Unica," the principal constituent of which is compressed cotton, is coming into use for silent gear power transmission. Tests carried out at the Royal Testing Institute in Berlin show that their resistence to indentation is 45 per cent. greater than that of German rawhide at 1,120 pounds pressure per square inch, and that they offer 100 per cent. greater resistance to displacement than rawhide at maximum pressure. Other advantages of the gears are stated to be that they are not affected by oil, and are cheaper than other types of silent gears. They can be key-seated the same as ordinary metal gears without fear of failure, and without the necessity of using bushings.

An English firm of egg importers, according to a report by U. S. Consul, Joseph G. Stephens of Plymouth, England, has inaugurated a new system of preserving eggs. Acting on the theory he says, that an egg decomposes owing to the entrance of bacteria through the shell, the eggs by the new process of preservation are first disinfected and then immersed in a vessel of hot paraffin wax in a vacuum. The air in the shell is extracted by the vacuum, and atmospheric pressure is then allowed to enter the vessel, when the hot wax is pressed into the pores of the shell, which thus hermetically seals it. Evaporation of the contents of the egg, which has a harmful effect, is thereby prevented, and the egg is practically sterile. The yolk of pickled eggs and others artificially preserved will frequently break on being poached, but the eggs preserved by this novel process are quite free from such fault.

Tunnel linings in rock far below the surface are often considered exposed to extremely heavy pressures, which do not come into play immediately on excavation. According to Dr. Karl Brandau, such evidences of general pressure were never experienced during the construction of the Simplon tunnel. Where the superincumbent mass was greatest, the lightest type of masonry lining was almost universally employed, and has never shown the least sign of damage. Wherever merely local and unimportant pressures were observed, they were invariably due to decomposed rock of small internal cohesion. He therefore believed that no considerable difficulties arise from the pressure of the superinposed rock in the construction of a tunnel, even at depths of more than 6,800 ft., in good compact stone, though great difficulties are experienced in plastic material of considerable thickness.

Rapid moving of a 12-in. high-pressure wrought-iron gas main, forming an important supply line to a 5,000,000-cu. ft. gasometer and high-pressure district, was recently accomplished at Santa Cruz, Cal. Owing to the construction of a storm sewer by the city, it was necessary to lower 300 ft. of the main about 3 ft., and also to move a 60-gal. flanged cast-iron drip pot in it, weighing 2,000 lb., some 150 ft. After excavating and bracing the ditch, which was in sandy soil, the main being supported on chain blocks and slings, the drip pot was first removed from the line and then the main lowered and the 150-ft. section between the old and new locations of the drip pot moved along to accommodate the latter. Next, by flange couplings, the pot was connected in at the new location and the ends at the former opening closed by a special sleeve coupling. This work was accomplished by seven workmen, and the main was out of service but 2 hours and 45 minutes from the time gas was turned off until turned on again.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

FEBRUARY 2.

911,041. PNEUMATIC TIRE. Edgar J. Hicks, Indianapolis, Ind.

911,056. AIR-GUN. William F. Markham and Ernest S. Roe, Plymouth, Mich.

911,161. AUTOMATIC COMPRESSED-AIR TRAIN SIGNAL AND STOPPING SYSTEM. Robert B. Robinson, Kansas City, Mo.

911,180. ROCK-DRILL LUBRICATION. James A. Thompson and Edwin M. Mackie, Chicago, Ill.

911,249. AUTOMATIC PRESSURE-REGULATOR. Primo Lulli, Uccle, near Brussels, Belgium.

911,294. STORAGE APPARATUS FOR LIQUEFIED GAS. Milton Chase, Haverhill, Mass.

911,389. RESPIRATION APPARATUS FOR USE IN COAL-MINES AND OTHER PLACES. William E. Garforth, Normanton, England.

911,431. SAND-BLAST APPARATUS. David A. Nicholas, New York, N. Y.

911,505. PRESSURE-REGULATOR. Arthur Kleinfeldt, Hoboken, N. J.

FEBRUARY 9.

911,610. MECHANICAL MERCURY-SEALED VACUUM-PUMP. Max von Recklinghausen, New York, N. Y.

911,649. EQUALIZING MULTIPLE AIR-LIFT FOR DEEP-WELL PUMPING. Robert H. Elsey, Coalinga, Cal.

911,726. BOTTOM-DOOR HOIST FOR FURNACES OR CUPOLAS. James Hyslop, Harvey, Ill.

911,752. WINDMILL. Edward T. Parker, Vermilion parish, La.

911,802. APPARATUS FOR SEPARATING HEAVY PARTICLES FROM AIR AND OTHER GASES. William J. Baldwin, New York, N. Y.

911,875. APPARATUS FOR MEASURING THE HUMIDITY IN OR DETERMINING THE EVAPORATING POWER OF THE AIR. Milo M. Hastings, Washington, D. C.

911,953. AIR-BRAKE APPARATUS. James O. Dodge, Los Angeles, Cal.

912,124. FLUID - PRESSURE INDEXING MECHANISM. Bengt M. W. Hanson, Hartford, Conn.

912,158. AIR-SHIP. Francis L. Orr, Omaha, Neb.

912,207. PNEUMATIC-ACTION CONSTRUCTION. Clyde H. Thompson, Meriden, Conn.

912,234. PNEUMATIC HAMMER. Alfred J. Doughty, Detroit, Mich.

912,243. VACUUM-BREAKER AND ALARM. Burton W. Hill, Somerville, Mass.

912,261. SPRAYER. Charles S. Perry, Chattanooga, Tenn.

912,269. AIR-BRAKE SYSTEM. George Macloskie, Jr., Schenectady, N. Y.

FEBRUARY 16.

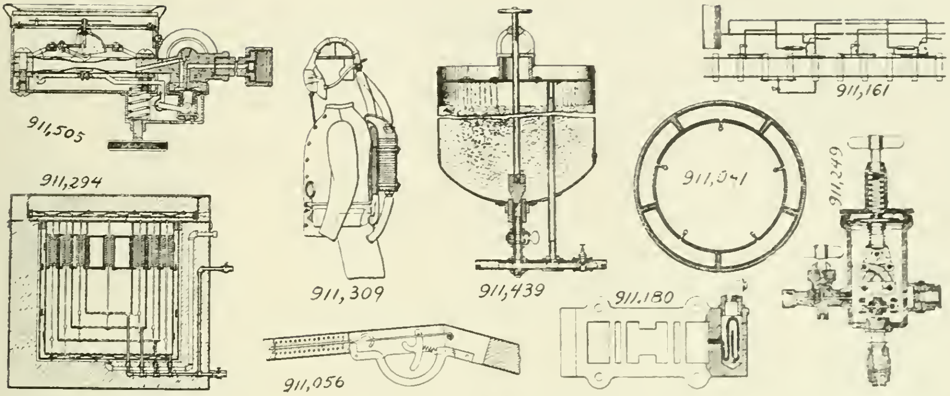
912,317. AIR-BRAKE APPARATUS. Howard M. P. Murphy, Pittsburg, Pa.

912,366. PNEUMATIC SELF-PLAYING MUSICAL INSTRUMENT. Lewis B. Doman, Elbridge, N. Y.

912,376. PNEUMATIC SPRING. William H. Humphreys, Liverpool, England.

912,502. FLUID - PRESSURE - CUSHIONING DEVICE. Charles E. Squires, Cleveland, Ohio.

912,549. ROTARY BLOWER. Lewis E. Fagan, Minneapolis, Minn.



Pneumatic Patents, February 2.

912,641. METHOD OF EFFECTING THE PRECIPITATION OF FLUE-DUST IN BLAST-FURNACES AND OF PREVENTING THE FORMATION OF THE SAME. Ralph W. H. Atcherson and William Siddall, Bellaire, Ohio.

The method of precipitating dust or solid matter from the furnace gas of blast furnaces and the like, which consists in directing throughout the whole of the gas zone of the furnace jets of a dust-dampening agent under high pressure for dampening the fuel-bed and for overcoming the momentum of such dust-particles as are carried in suspension by said gas.

912,647. MEANS FOR EXPANDING COMPRESSED AIR. Robert S. Cates, Kingman, Kans.

912,655. PNEUMATIC-TOOL HANDLE. William O. Duntley, Chicago, Ill.

912,706. AIR-VALVE CAGE FOR AIR-BRAKE PUMPS. James Mattingly, Marshall, Tex.

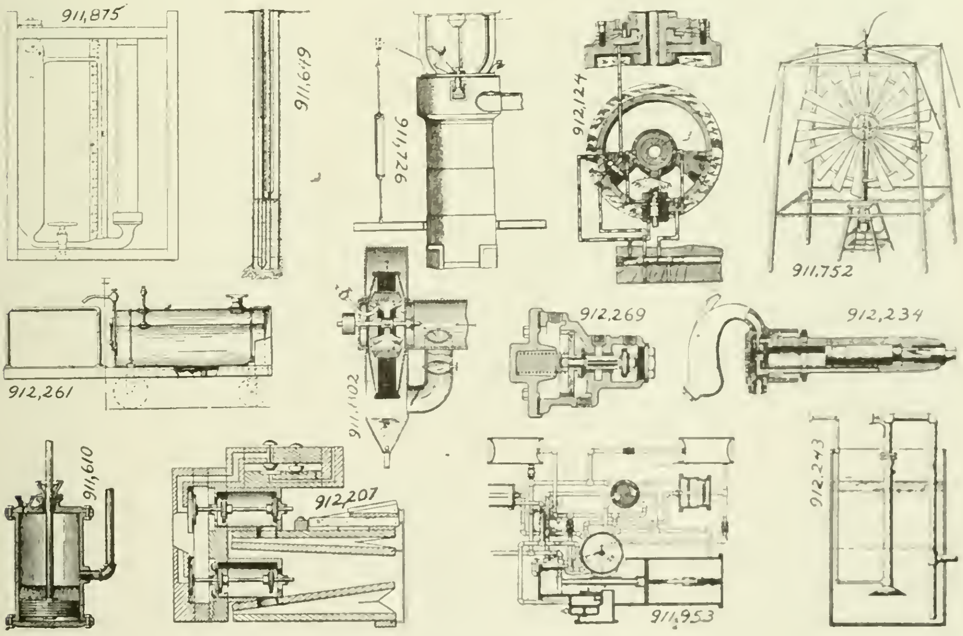
912,712-713-714-715-716-717. AIR-BRAKE APPARATUS. Howard M. P. Murphy, Pittsburg, Pa.

912,725. PNEUMATIC TIRE. George J. Paynter, Philadelphia, Pa.

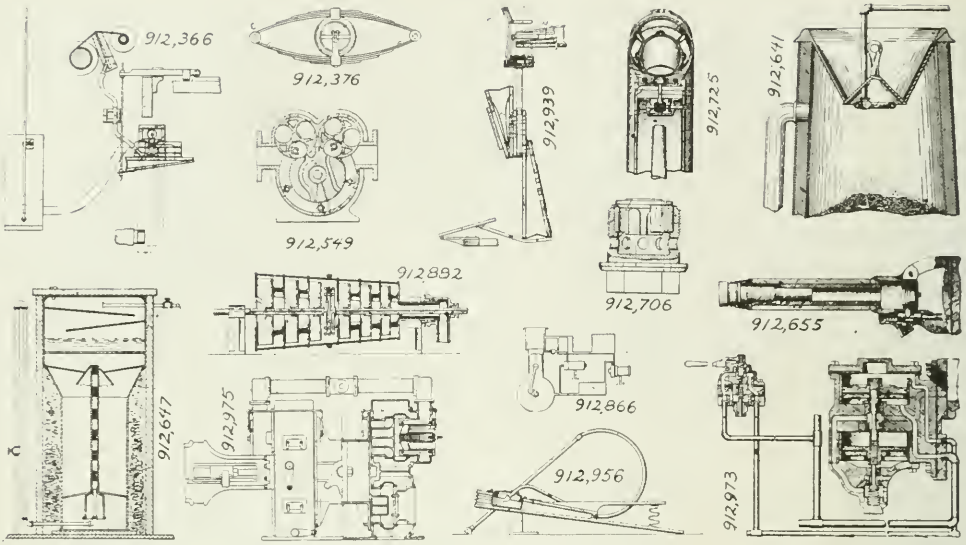
912,866. SYSTEM OF REFRIGERATION. Robert F. Massa, Chicago, Ill.

912,882. AIR-COMPRESSOR. Ole P. Oraker, U. S. Navy.

912,939-940. PNEUMATIC SELF-PLAYING MUSICAL INSTRUMENT. Lewis B. Doman, Elbridge, N. Y.



Pneumatic Patents, February 9.



Pneumatic Patents, February 16.

912,956. PNEUMATIC DUSTING AND SWEEPING APPLIANCE. Charles J. Harvey, Kidderminster, England.

912,973. AIR-BRAKE APPARATUS. Howard M. P. Murphy, Pittsburg, Pa.

912,975. AIR AND GAS COMPRESSOR. Fred E. Norton, Youngstown, Ohio.

FEBRUARY 23.

913,010. MERCURY VACUUM-GAGE. August B. Hohmann, Richmond Hill, N. Y.

913,058. ENVELOP OF AIR-PROOF MATERIAL. Addison T. Saunders, Akron, Ohio.

1. A pneumatic article of manufacture comprising an envelop containing compressed air, composed of a pliable gelatinous compound nonliquifiable by but adhesive under heat, substantially as described.

913,260. DEVICE FOR DELIVERING GASEOUS FLUID UNDER PRESSURE. Charles A. Claflin, Medford, Mass.

913,321. GAS-PRESSURE GAGE. Walter Thomas, Vancouver, British Columbia, Canada.

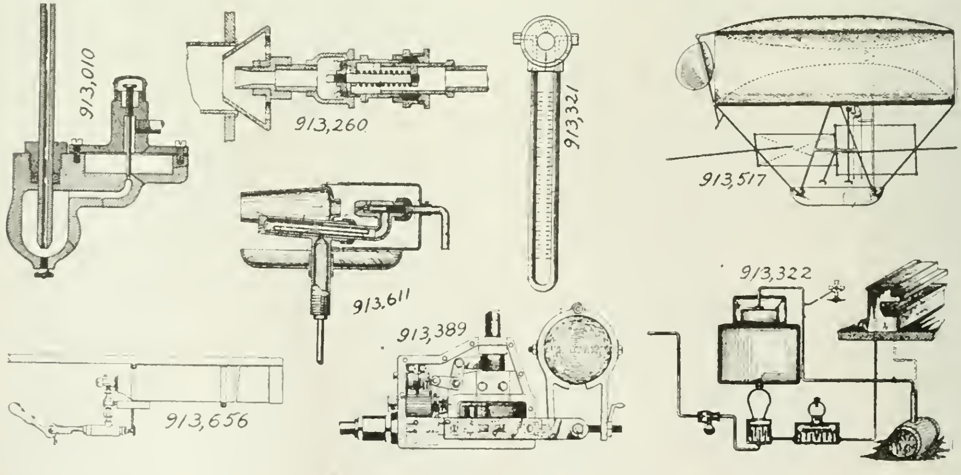
913,322. BLAST APPARATUS. Everett L. Thompson, Dover, N. J.

913,389. ROCK-DRILL. Leona H. Jenkins, Philadelphia, Pa.

913,517. AERIAL VESSEL. Christopher John Lake, (name changed from John Christopher Lake by judicial order), Bridgeport, Conn., and Spencer Heath, Washington, D. C.

913,611. BURNER FOR BLOW-TORCHES. Emil Beyer, Newark, N. J.

913,656. APPARATUS FOR CHARGING CAPSULES WITH LIQUEFIED GAS. Pierre Giron, Paris, France.



Pneumatics Patents, February 23.

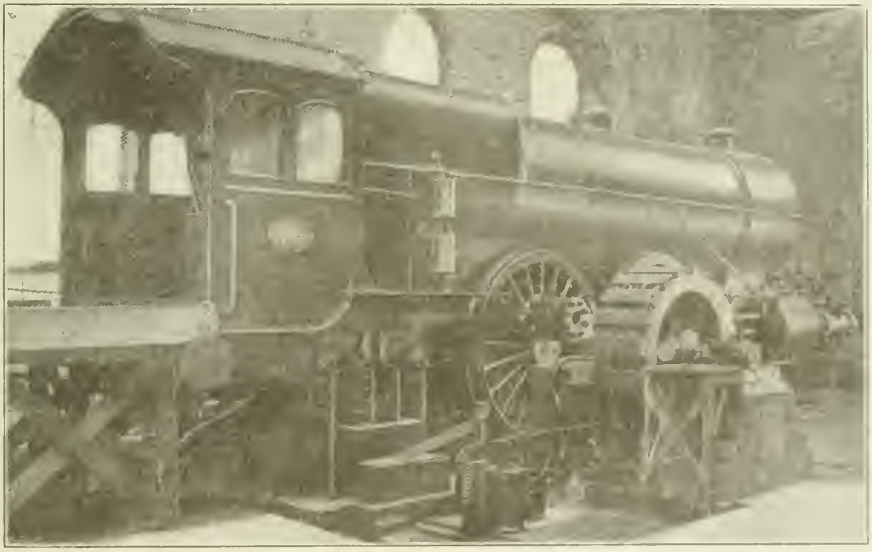
COMPRESSED AIR
MAGAZINE
EVERYTHING PNEUMATIC.

Vol. XIV MAY, 1909 No. 5

POWER DEVELOPMENT WITH A MIXTURE OF VAPOR AND NATURAL GAS

It is now an established fact, that a *mixture* of vapor and neutral gas is a more efficient and a more economic working medium than steam alone or than gas alone.

About twelve years ago, the alcohol explosion engine was taken up in Germany, but with very little success and gave the very low efficiency of about 6 per cent. Later experiments showed the necessity of greatly increased *compression* of the mixture of alcohol vapor and air before explosion. Increased compression gave increased efficiency. When the necessary degree of compression had been determined by experiment, then came the more important question of the degree of dilution with water. The commercial alcohol in common use contained 90 per cent. alcohol and 10 per cent. water, but the experimenters increased the percentage of water and decreased the percentage of alcohol until it was found that 83 per cent. alcohol and 17 per cent. water gave the highest efficiencies. It is clearly obvious that the alcohol is burned to Carbon-dioxide gas while the water is converted into steam. After explosion, this 83 per cent. alcohol and 17 per cent. water produce the best ratio of mixture of steam and gas or vapor and gas to secure the highest efficiency. It is stated by the best of authority, that two gallons of gasoline will not produce as much work in a gasoline engine as

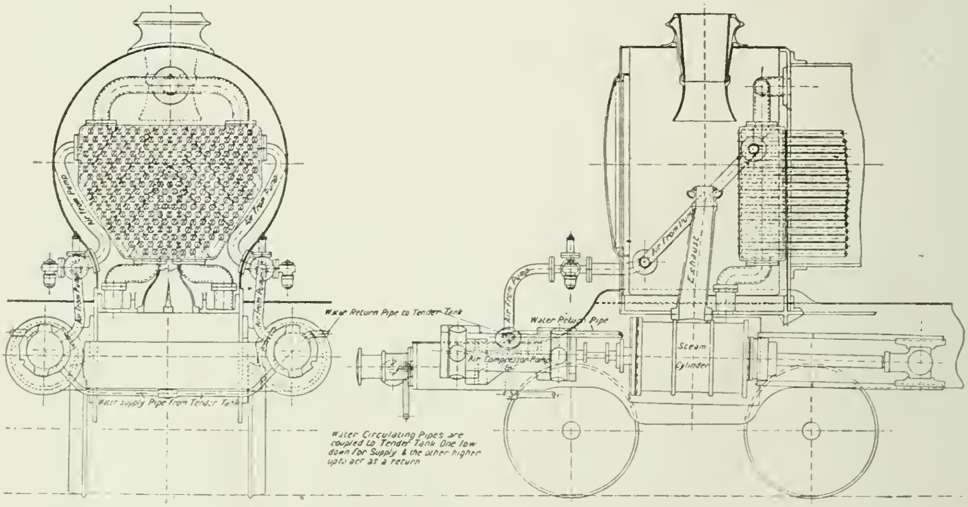


TESTING A STEAM-AND AIR LOCOMOTIVE

one gallon of dilute alcohol will produce in a specially constructed alcohol engine. The gasoline engine uses gas alone as its working medium while the alcohol engine utilizes a *mixture* of vapor and gas, or steam and gas, for its working medium; hence the greater economy.

Another demonstration of the higher efficiency of the *mixture* is shown by the locomotive in Fig. 1.

This locomotive is of the large Atlantic type and operates with a mixture of steam and compressed air or vapor and gas. Actual tests show a saving of 18 per cent. to 20 per cent. Other locomotives of the same character have been in continuous service for the last 16 months upon the British and Northern Railway in England.


Air from Pump
Air from Pump
Air from Pump
Air from Pump
Water Return Pipe to Tender Tank
Water supply Pipe from Tender Tank
Water Circulating Pipes are coupled to Tender Tank One low down for Supply & the other higher up to act as a return
Air from Pump
Water Return Pipe
Air Compressor Pump
Air from Pump
Exhaust
Steam Cylinder

SECTION OF STEAM-AND-AIR LOCOMOTIVE.

This locomotive has two cylinders in tandem, on each side. In the forward cylinder air is compressed to 200 lb. pressure, which is the steam pressure, and then delivered to a smokebox superheater where it is mixed with steam. In the rear cylinder the superheated air-steam mixture is utilized as a motive agent.

An outline view of this locomotive is shown in Fig. 2, both of these Figs. being reproduced from the *Engineer,* London. Fig. 2 will be recognized as having appeared with a somewhat unsatisfactory explanation in a previous issue.

As illustrated, the compression is performed by an external compressor cylinder placed tandem to the steam cylinder, which now operates with the mixture of steam and air, or, more generally speaking, operates with a mixture of vapor and neutral gas.

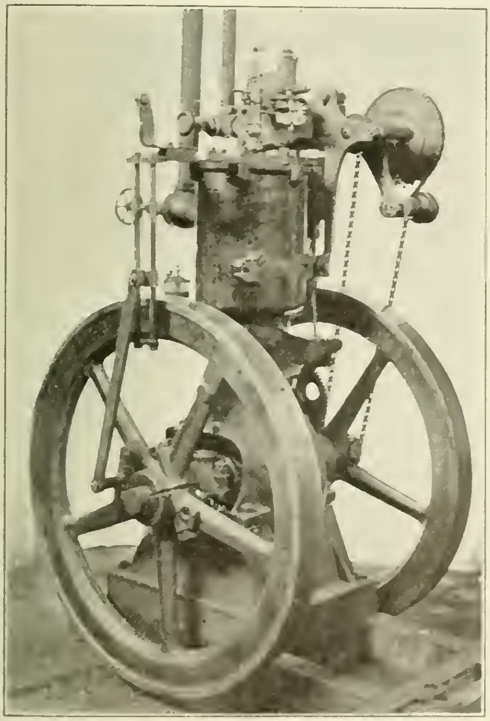
The latest experiments with the mixture of compressed air and steam, have been made by the "Christie Engine Company" of Marion, Iowa, and were conducted in the power house of the City Railway Company, at Cedar Rapids, Iowa, with the engine shown in Fig. 3.

This is a 6 by 8 in. vertical gas engine which was transformed into an air-steam engine, or a four-stroke-cycle steam engine. The operation is as follows: During the down stroke air is drawn into the cylinder; upon the up stroke the air is compressed; at the end of the stroke a valve opens to allow steam to enter and mix with the compressed air; the valve closes at some point in the down stroke, after which the mixture expands until the end of the down stroke; on the second up stroke, the mixture is exhausted from the engine, after which the process is repeated in order. No attempt has been made to determine the efficiency of the engine under consideration but indicator diagrams have been taken from it.

Fig. 4 shows a card with a very early cutoff, a compression of 55 lb. and a steam pressure of 65 lb. Fig. 5 was taken with a compression of 40 lb. and a steam pressure of 85 lb. and with early cutoff. Fig. 6 was taken under the conditions of Fig. 4 but with a late cutoff. Fig. 7 shows a late cutoff with a steam pressure of 130 lb. The speed of the engine was 125 r. p. m.

The chief merit of the Christie system is that it has the effect of giving a non-condensing engine all the advantages of a condensing engine without the necessity of a condenser or water for condensing purposes. The expanding air cools the steam, condenses it and decreases its pressure and temperature. The mixture of air and steam causes the steam to be superheated and the engine has the additional advantage of being supplied with initially superheated steam.

When air at 150 lb. is mixed with steam at 150 lb. the mixture will be at the same temperature as before for steam, but the air and steam pressures will each be 75 lb. The total heat of steam at 150 lb. being greater than that for 75 lb. allows intrinsic energy to be so changed that the steam will be superheated about 50 degrees.



EXPERIMENTAL AIR-AND-STEAM ENGINE.

This four-stroke-cycle system, compressing the air *within* the steam cylinder, will clearly avoid many losses which must be sustained by the *external* compressor shown on the locomotive in Fig. 1 and 2.

Larger and more important experiments are now proposed with the Corliss, four-stroke-cycle engine shown in Fig. 8. The air is introduced into this engine through an "Ingersoll-Rand" piston inlet valve; the piston tube extension is seen to the right of the cylinder. This engine will be tested by the Christie Engine Company at Marion, Iowa, under the supervision of Professor H. B. Mac Farland of Chicago.

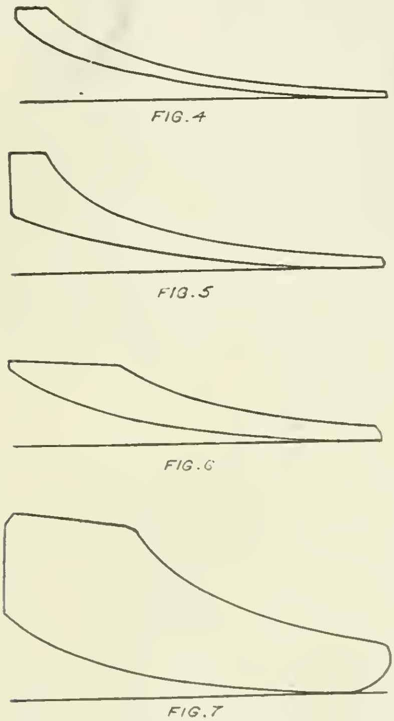


FIG. 4

FIG. 5

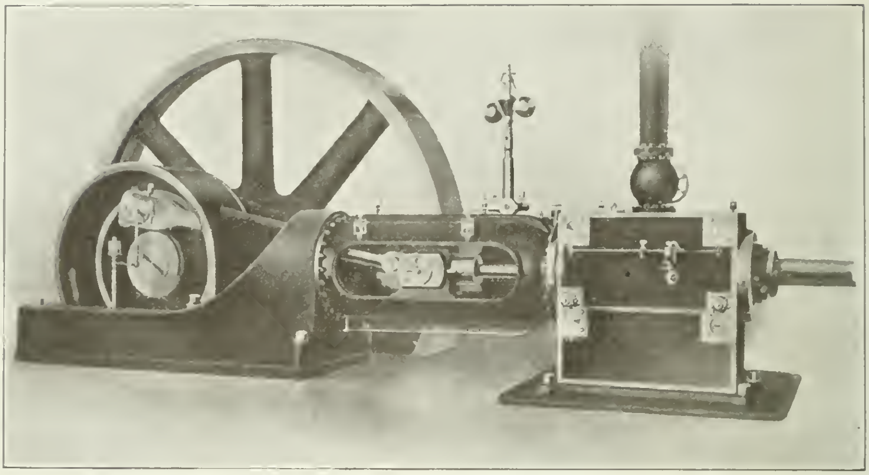
FIG. 6

FIG. 7

AIR-AND-STEAM CARDS.

The economy of a mixture of vapor and neutral gas is fully explained by the fact that, during expansion, there is a heavy transfer of heat from the steam to the gas (or air) in the mixture, the heat which is transferred is strictly the latent heat of the steam and the same latent heat which would otherwise go out at the exhaust of a steam engine.

This transfer of heat from the steam to the compressed air in the expanding mixture, is clearly demonstrated by the temperature curves shown in Fig. 9. One cubic foot of steam at 50 pounds pressure expanding to 10 cubic feet.



CORLISS AIR-AND-STEAM ENGINE.

drops from 280 degrees to 150 degrees; but one cubic foot of compressed air at 50 pounds pressure expanding to 10 cubic feet, drops from 280 degrees down to 165 degrees below zero. If the two were mixed at the same pressure and temperature, it must follow that the air could not grow so extremely cold but must receive a large amount of heat from the steam. This means practically the reheating of the compressed air throughout the entire expansion, and the high economy of reheating compressed air is fully set out in Chapter XVII, Richards on Compressed Air.

The laws for steam alone are well known, also the laws for gas or air alone, but the only laws for a *mixture of vapor and gas* are the laws of Gay-Lussac or Dalton.

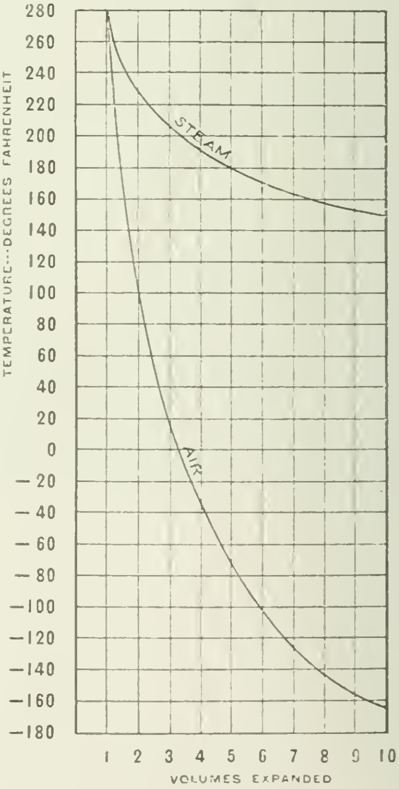
All saturated mixtures of vapor and gas obey the two following laws:

DALTON'S LAWS.

FIRST: The pressure, and, consequently, the quantity, of vapor which saturates a given space, are the same for the same temperature, whether this space contains a gas or is a vacuum.

SECOND: The pressure of a mixture of a gas and a vapor is equal to the sum of the pressures which each would possess if it occupied the same space alone.

This is practically a new field of research, and the *mixture of vapor and gas* may be introduced into several new systems of motive



COOLING IN EXPANSION.

power. In fact, the Christie Engine Company has already devised three separate and distinct systems to use the mixture, and all will be tested in the near future.

LAKE COPPER

The term "Lake Copper" came into use to designate the output of the Lake Superior copper district of northern Michigan. Owing to the fact that this Michigan copper was fundamentally different in its natural state or occurrence from that of most other copper districts, it was amenable to a process of refining which was different, both in operation and in standard of excellence, from the methods employed in refining copper from other regions. The consequence was, that this Michigan product was of somewhat different character and quality from copper produced elsewhere. The term Lake copper, therefore, in addition to its purely geographic significance, soon came to imply a particular grade or quality of copper, and it is undoubtedly in this double sense that the term has been generally used. So long as the actual character of this Michigan copper remained different and distinct from that of other copper, this dual significance of the term Lake copper caused no confusion. But with changing conditions that have affected both the Lake Superior product and that from other districts the early and established meaning of the term has been so warped and expanded that now in many cases it is impossible to decide from the name alone just what so-called Lake copper really is.—*Mining Science*.

BAROMETRIC CHANGES AND COAL MINE ACCIDENTS

The following is reproduced, with slight verbal changes and some condensation, from a contribution to *Copper Age*, Butte, Mont., by Mr. M. H. de Hora.

Every well-equipped coal mine should have at least two reliable mercurial barometers on the plant, one at the surface, preferably in the foreman's or manager's office, and one at the workings easily accessible to the shift-boss or underground mine captain.

One would think that if there was a class of people to whom the state of the weather made less difference than to another, that class would be miners. Working underground it is all one to them whether the sun shines or the rain pours, as at a few hundred feet below the surface, the thermometer remains about the same from one year's end to another; consequently, it makes no odds to the miners whether on the surface the heat be oppressive or whether the thermometer is below zero; but there is one class of miners, namely colliers, to whom a sudden change of weather means danger, often death, and certain material damage and delay occasioned by explosions.

Most of the horrible accidents occurring in coal mines can be proved to have been in a great part occasioned by sudden changes in the weather. We all know what happens when the barometer falls. It means principally that a load of air is being removed from above us. If the glass falls an inch, say from 30 to 29, it means that a weight of no less than 72 pounds has been removed from every square foot of surface, where atmospheric air is accessible.

This is how the fall of the barometer affects the coal miners. Coal is full of inflammable gases, of which the principal and most prevalent is that known to the miners by the significant name of "fire damp." When a seam of coal is being worked, the breaking out of the coal releases it from an enormous superincumbent pressure. This causes the gas to gush forth with such strength that at times it hisses and roars like steam escaping from a safety valve. As long as this gas is unmixed with atmospheric air, it is non-explosive Its only fatal action is merely suffocating; but when combined with air it forms a powerful explosive mixture, and is the chief cause of the mine disasters of which the list is so long and deadly. Now, the earth and the coal within it are equally affected by the diminution of pressure, of which the symptom is a heavy fall of the barometer The removal of external pressure allows the gas that is in the coal to escape more easily It is like the unscrewing or unweighting of a safety valve, with the consequent opportunity offered for the imprisoned steam to rush out; therefore the fall of the barometer corresponds with the unscrewing or the unweighting of the safety valve and the release and dangerous increase of inflammable fire damp mixed in the workings of the coal mine; and consequently the least spark, whether from a charge being fired or from a nailed boot treading on a piece of flinty rock, or even the spark arising from the jar of the point of a pick and from many other causes, will result in a fearful explosion. Many cases can be cited to prove that a decrease of atmospheric pressure is the invariable precursor of explosions in coal mines.

The most dangerous mixture of fire damp and atmospheric air is eight of air and one of fire damp, and it has been within the knowledge of experienced miners for more than thirty years that this mixture is more readily reached when the atmospheric pressure is low than when it is high. Rapid changes in the humidity of the air which is drawn from the surface by the ventilating of the mines causes dangerous transformation in the state of the floating dust; consequently, it becomes a most important duty of the coal mine manager and his subordinates to consult the barometer with as great care and attention as do the captain and officers of a ship, so that they can exercise that just prudence and precaution so necessary to avoid accidents.

AIR COMPRESSOR LUBRICATION

There is always a lurking danger where oils are used for lubricating air compressor cylinders, especially where the poorer grades of oil are employed. As our readers are frequently reminded many disastrous accidents have been traced to receiver or pipe line explosions caused by the vaporization of lubricating oils. There is also apt to be more or less trouble from the formation of hard carbon deposits. Instances are on record where it has been necessary to shut down and chisel the carbon deposit off the piston and valves.

By using Dixon's Flake Graphite and oil fed by means of a Graphoil Lubricator troubles with carbon deposits and dangers of explosion are reduced to a negligible quantity. Some concerns have advised the Dixon Company that instead of oil they have used soapsuds with flake graphite and have secured perfectly satisfactory results.

The booklet "Air Compressor Lubrication" published by the Joseph Dixon Crucible Company of Jersey City, N. J., contains much valuable information on the subject of air compressor lubrication besides suggestions for the best ways to feed the graphite. This booklet will be gladly sent to those interested who will write direct to the Dixon Company.

A METHOD FOR DETERMINING THE NUMBER OF DUST PARTICLES IN THE AIR*

By C. E. A. Winslow.

In many branches of sanitary work, notably the study of factory conditions, measurement of dust suspended in the air is of great importance. The actual number of dust particles present is probably quite as significant as the total weight of suspended matter. With dust of a given nature, it seems probable that damage to the lungs increases in proportion to the number of particles which lacerate their surfaces. Curiously enough, however, the enumeration of dust particles has not found place in most studies of ventilation problems. In some recent work carried out at the Sanitary Research Laboratory of the Institute of Technology, a method has been devised for this purpose.

The method consists in drawing a measured volume of air through a filter of granulated sugar, dissolving the sugar, suspending the contained dust in a known volume of distilled water and counting the dust particles present under the microscope. The sugar may be ordinary granulated sugar, the grains of which vary between 0.25 and 1 mm. in diameter. The layer of sugar should be 2 c.m. deep, and may be held in place in a glass tube of 1 to 2 c.m. base, by a perforated stopper and a square of bolting cloth. The air sample should be collected rather rapidly; and this may be done by the use of a suction cylinder of metal, with a closely fitting piston. After sampling, the sugar is poured into a small graduate and dissolved in 5 to 10 c.c. of distilled water. After thorough agitation 1 c.c. of the resulting suspension of dust in water is placed in a Sedgwick-Rafter counting cell, such as is used in the microscopical examination of drinking water. This cell is 50x20 mm. in area, and 1 mm. deep. The general method used in enumerating the dust particles is that described by G. C. Whipple in the "Microscopy of Drinking Water," for the study of the microscopical organisms. It involves simply the counting of the number of dust particles in a certain number of representative squares, and the calculation of the number originally present in the filtered air. In should be noted, however, that both the bottom of the liquid and its surface should be examined. Heavy dusts, of course, settle to the bottom, but lighter dusts may be found exclusively at the top of the counting cell.

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*A paper before the American Public Health Association, Winnipeg, Manitoba.

In my work I have filtered 600 c.c. of air and dissolved the sugar in 6 c.c. of water, thus giving a concentration of 100 in 1. I count 10 sq. mm. areas in the counting cell of 1-100 of the total number present in 1 c.c. of the concentrate. The number of dust particles thus counted corresponds directly to the number of dust particles in 1 c.c. of the original air.

It is, of course, essential that glassware and sugar should be clean, and it is desirable that control determinations should be made in order to avoid errors due to extraneous dust. I have found that 5 to 10 dust particles per square is an outside limit for this error with ordinary cleanliness. This corresponds to 50 to 100 dust particles per c.c. of air, and the method cannot probably be relied on below these limits.

Even with this qualification, however, the direct enumeration of dust particles offers a very delicate method for measuring dust in air. I have compared it with the method of weighing, with the following results, using dust swept up from the floor of the laboratory and shaken up in a large bottle, to give an extreme condition of dustiness. I found in one case that 16,000 dust particles per c.c. corresponded to a weight of 3 mg. In another case 13,000 particles per c.c. corresponded to a weight of 10 mg. With the dust method one can easily estimate numbers of dust particles down to 100 per c.c., which would correspond, in the case of the dust studied, with weights of 1-100 mg. or less, amounts which could hardly be determined accurately by the ordinary methods of filtering and weighing.

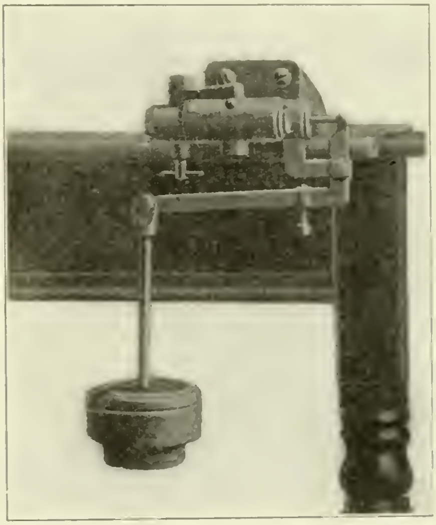
An additional point in favor of the method of enumerating dust particles is the opportunity for observing the nature of the particles themselves.

Their size may also be estimated if desired. The standard unit used in the microscopical examination of water (see Whipple), may be used for this purpose. It is not suggested that the enumeration of dust particles should in any way supplant the determination of the total weight of dust present. It is rather urged that it should be used in combination with the usual procedure for additional information.

AIR COMPRESSOR UNLOADER

The half-tone shows an unloader made by the Hunneymen Company, Concord, N. H., and designed to be applicable to any ordinary compressor.

In the main portion of this device are two cylinders with pistons ground to a fit. The main piston connects directly with the air tank, and the weights are so arranged as to control the air pressure within the desired limits. When the maximum pressure is reached the weight rises and allows the main piston to move and uncover the ports which connect it with the smaller piston. This is moved in turn and connects with the air pressure from the tank, and this reaches the valves of the air compressor, completely unloading it. The variation between maximum and minimum pressures may be from 4 to 20 pounds, but experience has shown that about 6 pounds is the most desirable for general use. After the compressor has unloaded and the pressure has been reduced the desired amount, the weights overcome the air pressure on the main piston and allow the small piston to return to its starting point. The compressor then gets to work again, and in this way the air pressure in the tank is controlled without waste of power, as is the case when the safety valve is used on the tank. The second or auxiliary valve connects the unloading valve directly



AIR COMPRESSOR UNLOADER.

with the air tank, so that its action is dependent entirely upon the pressure of air it contains. This can be arranged to control either the inlet or the discharge valve of the compressor as may be desired.

PHOTOGRAPHING UNDER AIR PRESSURE

Mr. William Munson Christie, LaGrange, Ill., in a valuable article on "Engineering Photography" in the *Engineering Record* of April 3, speaks of the special conditions attending the practice of photography in caissons, subaqueous tunnels and such places where the work must be done under abnormal air pressure.

The taking of such photographs, the writer says, is, at best, an unpleasant proposition and to one who has never experienced the conditions prevailing in this class of work, the job is not only unattractive, artistically and financially, but, also, it is a work attended with many dangerous risks. If one passes through the air-lock without getting "blocked," the after effects of the abnormal air pressure on the body are not pleasant. I have experienced these effects two and three weeks after being under air pressure ranging from 10 to 25 lb. And then again, these effects will pass away in a few hours or a day or two, depending, I presume, upon one's physical condition at the time of going under the air pressure. These after effects manifest themselves in a languor, more or less pronounced, symptoms not unlike those of malaria. Those who follow work, or are engaged in work carried on under air pressure, eventually are compelled to give it up. Laborers employed in this work often get what they call "the bends," a muscular or nervous disorder, affecting the lower extremities and, of course, the entire system. Pathologically speaking, it is a form of paralysis. The expressions, "the bends" and "blocked," are colloquialisms. Getting "blocked" is caused when entering the air-lock, or more definitely speaking, when passing from the normal to the abnormal air pressure the process of equalizing the air pressure on the ear drums and air passages in the nose and head is checked or stopped, or, in the expressive term, is "blocked." This results in piercing pains in the ears and across the eyes and through the region of the temples, and frequently in hemorrhages.

Another difficulty often attending photographic work under air pressure is the fact that the air in the tunnel or caisson is very frequently filled with fog, making it impossible to get clear, distinct pictures. This fog condition varies with the seasons of the year, the atmospheric conditions, the temperature outside, and whether it is cloudy or bright. I have been in caisson work where the temperature was as high as that of a Turkish bath. Emerging from the air-lock under such conditions into the frosty air of winter is like stepping from the tropics to the north pole.

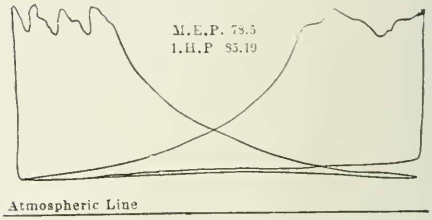


FIG. I

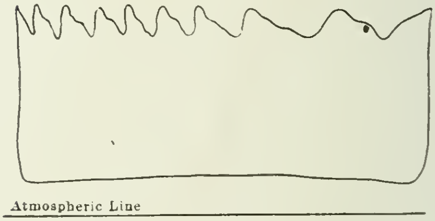


FIG. 2

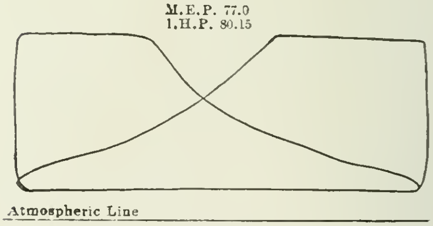


FIG. 3

STEAM SUPPLY IRREGULARITIES.

EFFECT OF IRREGULAR STEAM FLOW

Those who have to do with compressed air are sufficiently familiar with the jagged delivery lines so frequent on the air cylinder cards. The cards which we here reproduce from *Power and the Engineer* are from an air compressor, but are steam cylinder cards and therefore are a curiosity.

A 6-inch steam main from a battery of Heine boilers feeds, by means of a branch pipe, a 30 and 52 by 48-inch cross-compound noncondensing direct-connected engine. The pipe then diminishes in cross section and supplies an Ingersoll-Sergeant 16 and 32 by 36-inch cross-compound noncondensing air-compressor engine with Corliss valves.

When the dynamo engine is running, the intake line of the second engine shows considerable vibration; when the dynamo engine is not running, the intake line of the compressor engine becomes straight.

In Fig. 1 is shown a diagram of the high-pressure cylinder taken from the compressor engine when the dynamo engine was running under usual conditions. Fig. 2 shows a diagram taken under the same conditions, but with a 100 per cent. cutoff to show distinctly the characteristic vibration of the intake line on the compressor. Fig. 3 shows a normal diagram of the same cylinder, the compressor working under the same load, all the conditions being the same as in the first case, except that the dynamo engine is not running.

During these trials the dynamo engine made 103.5 revolutions per minute, developing 156 horsepower. The compressor engine made 23 revolutions per minute, compressing 750 cubic feet of free air per minute to an average pressure of 87 pounds.

The second diagram shows nine vibrations. Multiplied by 23, the number of revolutions per minute, gives 207 double vibrations per minute, which exactly corresponds to the number of strokes of the direct-coupled dynamo engine.

A comparison of the energies used in the compressor in the cases of Figs. 1 and 3 gives the following difference in favor of Fig. 3: Fig. 1, high-pressure cylinder, 86.193 horsepower; low-pressure cylinder, 75.33 horsepower. Fig. 3, high-pressure cylinder, 80.154 horsepower; low-pressure cylinder, 74.25 horsepower.

The vibration of the steam pressure in the main in this case causes a loss of about 4.4 per cent. in the efficiency of the compressor engine.

W. N. POLAKOV.

New York City.

In removing some natural cement concrete work in the harbor at Brest, France, which had been covered with sea water for 100 years, iron bars found embedded in this concrete, did not show the least indications of rust.

IGNITION OF FIREDAMP MIXTURES BY INCANDESCENT ELECTRIC FILAMENTS AND SPARKS*

The French Committee appointed to visit the Frameries testing station, having stated in its report that the results of the tests made there with reference to the ignition of firedamp mixtures by incandescent electric filaments and sparks, appear to contrast decidedly with the conclusions formed by Couriot and Meunier in 1906, namely, that sparks alone are capable of producing such ignition, an incandescent lamp filament having no such effect, the authors desire to correct the erroneous impression this unqualified statement is calculated to produce. They were the first to observe the possibility of maintaining the incandescence of the filament in an explosive mixture, and their experiments on this point led to the discovery of the superficial combustion of the inflammable gas around the incandescent filament—a phenomenon explained by the attraction of oxygen toward the filament. This attraction changes the proportions of the explosive mixture, so as to form an inexplosive sheath of gas; though if the incandescence and the radiation of heat are sufficient to raise the surrounding explosive mixture to the ignition point, an explosion will ensue. This result was observed by Heise, who used filaments of larger diameter than those employed by the authors, whose results with small filaments have recently been confirmed by Hauser.

The authors' tests that are suitable for comparison with those of Stassart were carried out with portable electric lamps supplied by the Arras Company, consuming 4 volts and 0.38 ampère. The mixture used contained exactly 0.5 per cent. of methane, as compared with Stassart's 8 per cent. mixture. In the authors' tests the filament was heated to redness in the mixture, but no explosion occurred until the filament broke; and therefore the explosion must be ascribed to the spark passing at the moment of rupture. Whichever be the true cause, however, the result is practically the same, since an exposed lamp filament will burn through in a few seconds and produce a spark. The difference resides in the interpretation of the physical phenomenon; and this is by no means negligible, as it is essential to

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*H. Couriot and J. Meunier. *Bulletin Soc. Industrie Minerale* know the exact manner in which the phenomenon occurs, not only from the point of view of safety, but also for other practical reasons; and purely empirical trials are not calculated to advance our knowledge on the subject, but can only lead to uncertainty.

On lighting carbon-filament lamps in an 8 per cent. mixture, traveling at a velocity of 40 in. per second, the committee stated that an ignition of the mixture occurred with the first lamp tried, and before the rupture of the filament; whilst with a stronger lamp seven ignitions were obtained in succession with the same filament. This indicates, as the authors have pointed out in the case of coal-gas mixtures, that ignition by simple incandescence may occur under certain favorable conditions. These conditions seems to have been almost attained by Stassart in his experiments; but not absolutely so, the third lamp tried (consuming 3.08 volts and 0.5 ampère) having burned for more than three minutes without producing an explosion. With the Arras lamp the authors found that the filament, though giving a brilliant light *in vacuo,* merely threw out a faint glow after the lamp was opened, and broke at the centre in a few minutes, without inducing an explosion. Similar negative results were obtained with five lamps; but on the lamps being surcharged with current, even though slightly, an explosion almost inevitably occurs on the rupture of the filament.

In the other tests made by Stassart, with metal filaments, one lamp (consuming 4.1 volts and 0.38 ampère) gave ignition immediately, but when tested again did not ignite the mixture until the filament broke. With an osmium lamp (1.8 volts and 1 ampère), owing to the low resistance, a first ignition was again obtained, but could not be repeated. The ampèrage was found to have diminished, no doubt in consequence of the filament becoming thinner as a result of gradual combustion, the resistance being thereby increased, as was observed in the tests carried out by the authors with strong lamps.

The question amounts to this, that firedamp mixtures are exploded either by the spark or by the incandescence of the filaments. The disruption spark, though infinitely more effective than incandescence, does not invariably produce ignition; and the authors believe they have established the main cause of the divergent effect produced by different sparks, namely, in the ratio between the resistance of the source of current and the resistance of the filament—the greater the resistance of the generating apparatus, the greater the igniting power of the disruption spark, even when the latter is small in volume. In the extremely large number of experiments carried out by the authors, they only succeeded in producing ignition when the filaments were of platinum wire below 0.2 mm. in diameter. The closed 10-candle lamps charged with a 9.5 per cent. mixture gave no ignition, even under a surcharge of voltage, except on the rupture of the filament, although it was expected, from previous experience, that an explosion would inevitably occur under such conditions.

SEARCHLIGHT SHELLS

Acetylene shells, which are being experimented with in the German navy, have so far proved much more effective at long distances than ordinary searchlights in lighting up large areas of water. These shells are said to contain calcium-carbide, and are so made that the water can reach it through a tube. The shells can be thrown upwards of 10,000 yards, by a gun constructed specially for the purpose, and it is hoped to increase this distance by suggested modifications of the weapon.

On being fired the shell eventually pitches into the water, and, the water entering the tube, its action upon the calcium-carbide produces the acetylene light. Each shell is said to have 3,000 candle-powder, and it will burn for no less than three hours. One of the chief advantages of lighting up an enemy's position in this way, over that of using a searchlight, is that a searchlight indicates the position of the ship, and gives a definite target for return fire by the enemy. With acetylene shells fired from a gun, the ship will relapse into darkness and her enemy be lit up by a few well-placed lights from the acetylene gun. The possibilities of the use of such a means of lighting up the horizon around a fleet, for the detection of the presence of torpedo boats, are very large, and cannot be taken in at a single mental glance. As a matter of fact a battleship would be able to imitate the particular fish who emits a fluid which beclouds the water and conceals his own movements; for the ship could light up the horizon with powerful flares to blind and expose its opponents, and then move about in the dark inner circles to the points at which it could best deal with them with its ordinary armaments. That is what our friends the Germans are doing, and we must follow suit if we would be ready for them by the time they are ready for us with their new 21-inch Whitehead torpedo, with an effective range of 7,000 yards or upwards. We have the lead, and every effort must be made to keep it.—*United Service Gazette.*

AERATOR OF SPRINGFIELD WATER WORKS.

A LARGE WATER AERATOR

The half-tone on this page, from a paper before the New England Water Works Association, by Mr. Carroll F. Story, shows in operation the aerator which is an important element in the water purification system of Springfield, Mass. The aerator is located where the corners of four rectangular filter beds come together. There is a concrete basin 30 feet in diameter and the water is aerated by overflowing from the elevated end of a 30 inch vertical discarge pipe. The water is raised from the reservoir into the aerator by a 20,000,000 gallon centrifugal pump. Sixteen outlets from the basin, each furnished with a gate, provide for the discharge of the water into either of the filters as desired.

A SCIENTIFIC ENIGMA

Carbon, represented as it is in the form of graphite, the diamond, charcoal, coal, lampblack, etc., has about it an impenetrable mystery. According to Professor Larkin of California, it is archaic and eternal, omnipresent and primordial. The spectroscope that marvel of all ages, shows carbon glowing in the sun at white heat, and we know that it burns —that is, unites with oxygen in our bodies—thus keeping us alive by the evolution of heat. Carbon is the concentrated life of nature.

You can get equal quantities of carbon for one cent or for one million dollars. To strike up a bargain it would seem that the investment of one cent would be the wisest. You can obtain a piece of carbon in the form of graphite for one cent. You will find it as black as the ace of spades is said to be. It is not only jet black, but is smooth, soft and friable.

If you want the same weight of pure white carbon, it may be had in the shape of a diamond for a million or two. In this shape the carbon is the hardest body known, and the most difficult to melt, yet electricity is able even to make diamonds liquid

Therefore, carbon is found pure in the diamond, nearly or quite pure in graphite, which is the material in our lead pencils, and for some inscrutable reason is it called "lead." Carbon is also found in charcoal, coal, coke and petroleum.

All animals and plants contain carbon in their tissues; it is in the air, in the earth and is found in comets.

The carbon in the comet is not free, but is joined chemically to hydrogen in a body called a hydrocarbon. The comet comes to us from the appalling depths of space on a visit to the solar system. It comes to us and then goes away, frequently never to return, but the question is where did it get its carbon, for the spectrum of a comet shows light like that emitted by common gas, which is known to be carbon and hydrogen.

Hydrogen is always present in the most primitive forms of nebulae in space, and in the latest sun. Hydrogen is ever present near the "beginning" of cosmic evolution, and has a strong affinity for carbon, with which it combines in many proportions.

Meteors, also from the depths of space, bring carbon to the earth and sun. Those that reach the earth have in several instances contained carbon in the shape of diamonds, not very popular, however, because black, but good enough to cut glass with.

Of all conceptions that can fill the mind with sublime thoughts, the white hot liquid carbon envelop of the sun is the most impressive.—*Graphite.*

Most everyone familiar with the use of peroxide of sodium knows that coming in contact with moisture it will generate intense heat and if it has anything inflammable to work on will "start something." A young man working for a Chicago firm mastered all the ingredients of a desired formula but one. This one (a powder) he took a small amount of in a piece of paper and puts it in his hip pocket. The day being warm, he was in a profuse perspiration. It did not take long for the moisture from his body to get action on the peroxide of sodium and there was "something doing" at once. A broken plate glass window was no bar to the hurried progress of the young man in his endeavor to reach safety, but the glass cut some figure in the expense of his experiment.—*National Laundry Journal.*

TESTS UPON COMPRESSED AIR PUMPING SYSTEMS OF OIL WELLS

By Edmund M. Ivens.

When the Louisiana oil fields at Evangeline were in full operation, they offered exceptional opportunities for the study of air lifts. Nearly every known method of piping the wells was in use. The air plants originally installed were the crudest affairs imaginable, having been erected in feverish haste during the boom several years ago. When the production of the fields began to decrease, and the price of oil also declined, it was realized for the first time that the operating expenses were abnormal, and that unless greater economy were practiced, disastrous results would follow.

Each concern has a central station or air plant and all the compressors therein are connected to a manifold from which the air lines lead to the various wells on the property. Ofter the air lines reach the wells by a roundabout way, and have innumerable short bends, valves, double swings to avoid pipe cutting, and plugged tees instead of elbows. The size pipe used for these air lines is designed neither for the amount of air to be transmitted nor for the distance it is to be carried, but is with one exception 2 in. in diameter. The boilers of the air plants are of 40 h.p., of a portable, contracted waist type, and few were covered with asbestos. The boilers were so set that one-fifth of their lengths projected into the open.

The redeeming feature in all the plants is the type of compressor in general use. These compressors are generally of high grade, and display remarkable endurance. It is common for a machine designed for 350-lb. pressure to operate under a pressure of 500 lb., and at speeds far in excess of those for which it was designed. The most popular type of compressor has the duplex steam end and compound or two-stage air end. The steam cylinders are fitted with Meyer adjustable cut-off valves and the air cylinders in some instances with piston-inlet and in others with Corliss intake valves and poppet discharge valves. Plain speed governors are used and the capacities of the compressors range from 100 to

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*Presented at the Spring Meeting of The American Society of Mechanical Engineers. (Abridged.)

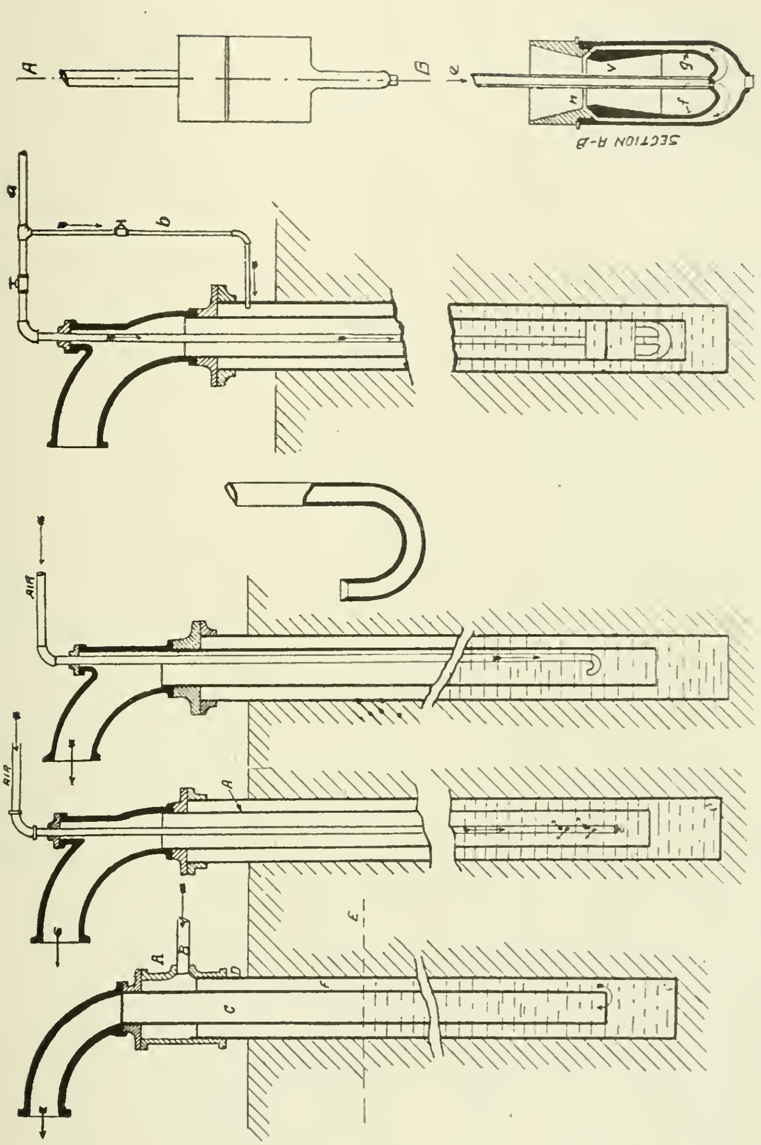


Fig. 1
Straight Air Lift System

Fig. 2
Central Pipe System

Fig. 3
Return Bend System

Fig. 4
System Combining Features of other Systems Described

1,000 cu. ft. of free air per minute and operate at pressures of from 150 to 750 lb. per square inch. The machine best adapted to the purpose, however, is the 500 cu. ft., 500-lb. type

TERMS.

"Submergence in feet" refers to the number of feet below the surface of the fluid (after the well has been pumped down, and is operating under its normal conditions) that the air under pressure is admitted. "Per cent. of submergence" is the submergence in feet divided by the total number of feet of vertical discharge line, measured from the point of admission of the air to the point of discharge of the fluid. "Volumetric efficiency" of the compressor is the actual amount of free air that is compressed and discharged by the cylinder, divided by the cubical contents [actual piston displacement] of the cylinder. "Free air" is air at normal temperature and pressure. "Pumping head" is the vertical distance in feet (after the well is pumped down) from the fluid level in the well to the point of discharge.

$$\text{"The Constant"} = \frac{\text{Gal. per minute} \times \text{pumping head in feet}}{\text{Cu. ft. of free air per minute}}$$

$$\text{"The Ratio"} = \frac{\text{Cu. ft. of free air per minute}}{\text{Cu. ft. of fluid per minute}}$$

DESCRIPTION OF SYSTEMS.

Figs. 1, 2, 3 and 4, illustrate the air lift systems that are and have been in use on the oil fields.

Fig. 1 shows the Straight Air or Saunders system. The well top is sealed as shown at A. Compressed air is forced through the pipe B into the space between the discharge or eduction pipe C, and the well casing D. When without air pressure the fluid in the well will stand at some point such as E, the level in the air space and the discharge line being identical. When air is forced through B, the level of the fluid in the air space is gradually forced down until the end of C is uncovered. Instantly some of the air escapes into the discharge pipe C, lowering the air pressure in the air space F. This causes the fluid to rise in and up the air space and discharge pipe until a point is reached where air and water pressure balance. Then, more air coming in, the pressure again rises, the fluid level is forced down as before, more air escapes into the discharge pipe, and thus the cycle is repeated. As may be readily seen, the air that rushes into the discharge line carries the "slug" of water that has just previously entered.

Fig. 2 shows what is commonly known as the Central Pipe system. The discharge line A is placed inside of the well casing as before, and inside of the discharge is suspended a small air line usually 1¼ in. in diameter. The end of the 1¼ in. line is plugged and a number of ⅛ in. holes are drilled inclining upwards in the last joint of pipe. Air is forced down through the small air line shown, passes out of the ⅛-in. holes, and mingles with the fluid, carrying it out through the discharge line A. It is generally supposed that the fluid in this case is discharged because of the aëration of the fluid in the discharge pipe, which in turn is caused by the intimate commingling of air and fluid. The weight of the fluid column inside of the discharge pipe is therefore less in pounds per square inch than that without and the energy due to this difference in weight is utilized to lift the fluid and overcome the various losses.

What is commonly known as the Open End system of air lift was at one time in quite extensive use on the field. It is similar to the system just described except that the small air line is open at the lower end, and of course there are no holes drilled in the air line.

Fig. 3 illustrates a form of the Return Bend system. It is claimed by the inventor that: "It consists in improved processes and apparatus whereby the compressed air is delivered in bulk into the lower end of the water eduction pipe, and the water and air are caused to ascend through said pipe in distinct alternate layers of definite dimensions."

Fig. 4 shows a patent system which in reality is a combination of the several systems already described. The claims of the inventor are: less submergence, and hence less air pressure necessary, decreased air consumption, or, with an equal amount of air, increased fluid yield.

Compressed air is forced through *a* down into the foot piece, which is placed at that point of submergence shown by test to be most economical. The well top is sealed and air under pressure is also admitted between the casing and discharge pipe on the water head by means of the branch shown at *b*. This forces the fluid to a higher level in the discharge pipe and also prevents fluid in the air space or chamber from vibrating and foaming. This is quite an advantage in oil well pumping, as the liability of making "riley oil" is thereby greatly lessened.

The footpiece shown in section is made of cast brass and is in two parts. The air on reaching the footpiece divides and goes up through the hollow prongs *f* and *g* and out the nozzle *n*. The nozzle is adjusted to receive the quantity of air to be used by screwing the upper part *s* of the footpiece, in or out as the case may be. To increase the velocity of the fluid in the discharge line, the footpiece is restricted and formed into a "venturi" as shown at *v*.

TEST NO. 1.

The Crowley Oil and Mineral Company was the first to take active steps for the improvement of their plant and pumping equipment.

They decided to install the patent air lift last described (Fig. 4). A test of the old system was first made to determine the amount of compressed air used and the fluid yield. The new equipment was next installed and a similar test made of the same duration and under the same conditions. The tests and installation were conducted on Well No. 32, 1,805 ft. deep, and located 542 ft. from the compressor operating it. The air to the well was controlled by means of a manifold in the plant and was conveyed to the well top through a two-in. pipe line which as usual was in poor condition and badly designed.

The system of pumping was that illustrated in Fig. 1. The well casing was 6 in. in diameter, suspended inside of which was a 4-in. discharge line.

The compressor was a duplex steam and compound air type, made by the Ingersoll-Rand Company and designed to compress 1,000 cu. ft. of free air per minute to 350 lb. pressure. The steam end was fitted with Meyer adjustable cut-off valves and the air end with Corliss intake and poppet discharge valves.

The discharge pipe from the well top was run up into a steel tank of known dimensions

TABLE 1 SUMMARY OF RESULTS

The Crowley Oil and Mineral Company, Evangeline, La.

	Old System	New System
Duration of test, hours	5.5	6.0
Mean i.h.p.	122.56	89.19
Mean water h.p.	9.97	10.36
Mean air h.p.	107.38	79.16
Gallons of fluid per second	0.542	0.608
" " " " hour	1953.6	2188.2
Barrels of fluid per hour	46.51	52.1
Weight of 1 gal. of fluid	8.7	8.69
Mean temperature of fluid, deg. fahr.	111.5	113.2
Percentage of salt water in fluid	87.3	86.7
" " sand "	2.2	1.9
" " crude oil "	10.5	11.4
Barrels of oil per hour	4.86	5.94
Barometer reading, inches of mercury	29.95	29.94
Specific gravity of oil	0.9	0.9
Constant	63.1	101.8
Size of air line, inches		1.25
Total depth of well, feet	1805.0	1805.0
Size of casing, inches	6.0	6.0
Height above ground to which the fluid was pumped, feet	18.5	18.5
Size of discharge line used, inches	4	4
Total length of vertical discharge line	1513.5	1513.5
Total length of vertical air line in well	1513.5	1493.0
Dimensions of compressors, inches	10x22x16x20–	7½x18x16x20
Number operated	1	1
Kind of fuel used	Crude oil	Crude oil
Gallons of fuel used per hour	48.36	35.27
Barrels of fuel used per hour	1.15	0.835
Price of 1 bbl. of oil at time of test, dollars	0.90	0.90
Cost of fuel for producing 1 bbl. of fluid, dollars	0.0222	0.0146
Cost of fuel for producing 1 bbl. of crude oil, dollars	0.212	0.126

and the amount of fluid pumped during the test ascertained by direct measurement. Air gages were placed both at the compressor and at the well top, thereby making it possible to determine the friction losses in the manifold and air line and also the actual pressure at the well top. Simultaneous indicator cards were taken from the steam and air ends of the compressor, and from these cards were obtained the volumetric and mechanical efficiencies, the steam and air horse powers, and the steam consumption (theoretical) of the machine.

When these tests were run, no attempt was made by the writer to re-design the air lines, or to correct in any manner the numerous other defects. The old system was tested just as it had been operated, and the new system was installed and tested under the same ad-

TABLE 2 SUMMARY OF RESULTS

WELLS NO. 12, 30, 32, CROWLEY OIL AND MINERAL COMPANY

Duration of tests, hours	6.0
Mean (total) i.h.p.	151.1
“ “ w.h.p.	25.14
“ “ a.h.p.	129.05
Total gallons of fluid per hour	6168.0
“ barrels “ “ “ “	146.87
“ “ “ oil “ “	16.17

WELL NO. 12

Weight of 1 gal. of fluid	8.5
Temperature of fluid	118.5
Per cent of salt water in fluid	87.2
“ “ “ sand “ “	1.3
“ “ “ crude oil “ “	11.5
Barrels of oil per hour	6.44
Specific gravity of oil	0.87
Total depth of well in feet	1705.00
Size of casing, inches	6.00
“ “ discharge line, inches	4.00

WELL NO. 30

Height above ground to which fluid was pumped, feet	17.5
Total length of vertical discharge line	1025.5
“ “ “ “ air line	992.58
Weight of 1 gal. of fluid	8.65
Temperature of fluid	120.2
Per cent of salt water in fluid	88.3
“ “ “ sand “ “	1.5
“ “ “ crude oil “ “	10.2
Barrels of oil per hour	4.83
Specific gravity	0.9
Total depth of well in feet	1920.00
Size of casing, inches	6.00
“ “ discharge line, inches	4.00
Height above ground to which fluid was pumped, feet	18.00
Total length of vertical discharge line	1516.3
Total length of vertical air line in well	1494.2

Well No. 32

Weight of 1 gal. of fluid, pounds	8.7
Temperature of fluid	114.5
Per cent salt water in fluid	86.9
" " sand " "	1.8
" " crude oil " "	11.3
Barrels of oil per hour	4.90
Specific gravity	0.9
Total depth of well, feet	1901.00
Size of casing, inches	6.00
" " discharge "	4.00
Height above ground to which fluid was pumped	18.5
Total length of vertical discharge line	1513.0
Total length of vertical air line in well	1493.0
Size of air lines in wells, inches	1.25
Barometer reading, inches of mercury	29.95
Dimensions of compressor, inches	10x22x16x20
Number operated	1
Kind of fuel used	Crude oil
Barrels of fuel used per hour	1.45
Price of 1 bbl. of oil at time of test, dollars	0.90

verse conditions. After both systems had been tested, some few of the defects were corrected in the manifold and air line design, thereby insuring more economical operation in the future.

TEST NO. 2.

WELLS NO. 12, 30 AND 32 OF THE CROWLEY OIL AND MINERAL COMPANY.

The saving in air volume accomplished by the new system led those interested to endeavor to operate two wells with one machine, something before considered impossible in the field.

Well No. 30 was forthwith tested, though not with sufficient accuracy to warrant the publication of the results, and the approximate pumping head and submergence established The new system was then installed with the requisite pipe to equalize the submergence (hence working pressure) of this well with that of No. 32.

The two wells in question were then connected to one air compressor with gratifying results. No trouble was experienced in starting, and the machine furnished air in abundance for steady operation.

Preparations were being made to run the usual test when the compressor operating Well No. 12 "went dead." This last named well had been previously tested and equipped with the new system. This shutdown, of course, would mean a loss of at least a day's production from the well, amounting to quite an item, so the writer advised that this well also be connected to the machine already operating No. 30 and No. 32. By speeding the machine up a few revolutions, the additional load was easily taken care of as may be more fully noted by reference to the accompanying log (Table 2).

TEST NO. 3.

MILL HILL NO. 2, MAMOU POWER COMPANY.

This test was run in the same manner as those preceding except that the fluid field was ascertained by means of a two-foot rectangular weir placed between the earthen fluid and oil pits, the salt water bleeds of the former having been closed. The old system used was that illustrated in Fig. 2.

The depth of fluid over the crest of the weir was measured by means of the ordinary hook gage calibrated to read accurately in hundredths of a centimeter. The weir constant

TABLE 3 SUMMARY OF RESULTS

WELL NO. 2, MAMOU POWER COMPANY

	Old System	New System
Duration of tests, hours	10.0	10.0
Mean i.h.p.	99.1	62.8
“ w.h.p	9.85	13.36
“ a.h.p	82.5	50.4
Gallons of fluid per second	0.694	0.849
“ “ “ “ hour	2499.6	3056.4
Barrels of fluid per hour	54.75	72.77
Weight of 1 gal. of fluid, pounds	8.72	8.75
Mean temperature of fluid, deg. fahr.	118.3	117.9
Percentage of salt water in fluid	87.7.	86.1
“ “ sand “ “	1.2	1.6
“ “ crude oil in fluid	11.1	12.3
Barrels of oil per hour	6.08	8.95
Specific gravity of oil	0.9	0.9
Barometer reading, inches of mercury	29.94	29.93
Weir constant	24.39	24.39
Pumping constant	97.1	202.9
Total depth of well in feet	1901.0	1901.0
Size of casing, inches	6.0	6.0
Height above ground to which fluid was pumped, feet	3.33	3.33
Size of discharge line used, inches	4.0	4.0
Size of air line in well, inches		1.25
Total length of vertical discharge line	1500.0	1500.0
Total length of air line in well	1489.5	1489.5
Dimensions of compressor, inches	7½x18x16x16 –	7½x18x16x16
Number operated	1	1
Kind of fuel used	Crude oil	Crude oil
Gallons of fuel used per hour	44.22	30.53
Barrels of fuel “ “ “	1.05	0.727
Price of 1 bbl. of oil at time of test, dollars	0.85	0.85
Cost in fuel of producing 1 bbl. of fluid, dollars	0.0163	0.0085
Cost in fuel of producing 1 bbl. of crude oil, dollars	0.128	0.069

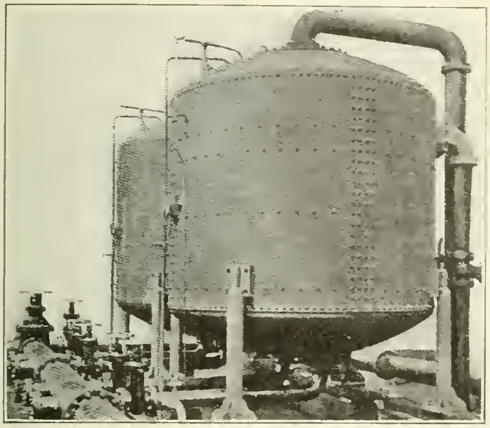
was previously determined by testing in the usual way, using a sample of the fluid as pumped from the well.

At the University of Wisconsin recently one hundred and fifty city engineers, general managers of power and traction companies, contracting engineers, superintendents of water and light plants, mechanical and civil engineers and superintendents of highway construction organized the Engineering Society of Wisconsin. The officers elected were: President, F. E. Turneaure; vice-president, McClelland Dodge; trustees, B. F. Lyons, E. P. Worden, E. Gonzenbach and E. R. Banks.

A COMPRESSED AIR OXYDIZING FILTER

The following description of the Candy compressed air oxydizing filter we abstract from a paper by Mr. John Don before the Institution (British) of Mechanical Engineers. Candy is of course the name of the inventor of the filter.

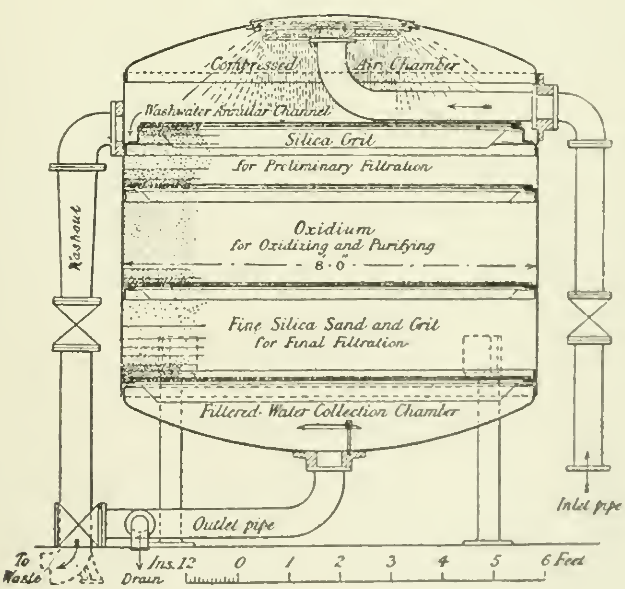
Against the use of coagulants their have been urged various objections, some rather fanciful, others more real. There is the question of expenditure, representing an outlay of $1.25 to $2.50 per million gallons filtered ($1.50, on the average, per grain per gallon per million gallons). It is to be recognized also that it may be beyond the capacity of the ordinary attendant of a filtering plant to determine the exact amount of coagulant which should be added under varying conditions of the raw water.



CANDY COMPRESSED AIR AND OXYDIZING FILTER.

Oxidium, which is the effective medium of the Candy filter, is a porous composition of iron oxide, silica, etc., which exhibits properties similar to those of spongy platinum. Consisting largely of iron and silicates, oxidium absorbs oxygen from the air and yields it again to organic matters suspended or dissolved in the water under filtration. Living germs are intercepted as efficiently as in any of the filters described in the paper. It appears that wet combustion proceeds rapidly as the water percolates. The oxygen is supplied from the pores of the oxidium, wherein it is occluded. The stored oxygen is gradually used up as filtering goes on, but it is easily renewed by emptying the cylinder and admitting air. By a simple means a large volume of air is compressed into the dome of the cylinder, so that the descending water is well aerated.

Dr. Thresh has made many analyses of the effluents of the Candy filters, and the purification in general has been shown to be admirable. Practically speaking, there is no escape for pathogenic bacteria. Albumenoid ammonia is reduced to an insignificant amount. Nitrification makes great progress in passing through the layers of oxidium. Iron salts in solution are wholly got rid of. These are conclusions which may be drawn from Dr. Thresh's investigations.


Compressed Air Chamber
Washwater Annular Channel
Silica Grit
for Preliminary Filtration
Oxidium
for Oxidizing and Purifying
8·0
Fine Silica Sand and Grit
for Final Filtration
Filtered Water Collection Chamber
Washout
Inlet pipe
Outlet pipe
To Waste
Drain
Ins. 12 0 1 2 3 4 5 6 Feet

SECTION OF CANDY FILTER.

THE MEASUREMENT OF COMPRESSED AIR

Before the Transvaal Institute of Mechanical Engineers, recently, Professor Orr read an important paper on "The Measurement of Compressed Air and How the Problem Affects Stope Drills and Central Compressed Air Stations." Professor Orr pointed out that an added importance had been given to the subject owing to the initiation of the Transvaal Stope Drill Competition, in which the air consumption was going to constitute an item of some weight, and, further, to the recent decision to establish a huge central compressed air station in connection with the mines. The distribution of air from central stations was by no means new, but the measurement of the air has always been a question of considerable difficulty. The air consumption of rock drills had been a matter frequently referred to at the Institute, but the measurement had on each occasion been based on the readings of a meter intended to measure water. Taking the ordinary types of water meters, as used for distribution, they might be divided into: (a) Inferential meters; (b) volume or capacity meters; (c) displacement meters. No doubt any water meter could be used as a compressed air measurer, but in the majority of cases calibration by passing known weights of air at constant pressure through them would be necessary. Professor Orr stated that he had in the College Laboratory twelve examples of water meters, but so far the only one which had been thoroughly tested was the displacement meter made by Kennedy, and which had been the type used in previous rock drill tests on these fields.—*South African Mining Journal.*

CANDLE-POWER UNSATISFACTORY AS A GAS STANDARD

The annual report (1908) of the Public Service Commission of the second district of New York says:

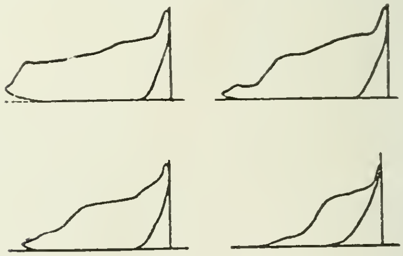
The employment of the candle-power standard in this state in determining the value of gas is subject to fair criticism. When gas was used solely as an illuminant, and by means of open-flame burners, its value was properly measured in terms of another illuminant, the candle, as a standard. In recent years, incandescent mantles have largely displaced the open-flame burners. The light given off from this device is generated by raising the mantles to a high temperature. In recent years also gas has come into existence as a fuel. Under these conditions, a very small percentage, probably in this state less than 20 per cent. of the total gas consumed, is now used in open-flame burners.

As the measure of the value of gas should be based upon the preponderance of purposes for which the gas is used, the candlepower as a standard apparently has come to be of minor importance.

For the purpose of confirming this, the commission has begun a systematic series of tests which will determine the heating properties of gas as now supplied under candle-power restrictions, and whether the establishing of the heating value as a standard will not result in giving a more satisfactory service than the commonly used candle power standard.

CARDS FROM AN ADJUSTABLE CUT-OFF ROCK DRILL

The indicator cards herewith, which we reproduce from the *Pacific Miner*, are from an air operated rock drill made by the Mitchell Machinery Company, Denver. The drill cylinder is 2¾ in. diameter, 4 in. stroke, with "17 pound hammer," the latter, we assume, being the weight of piston and chuck, with presumably also the steel. The drill is provided with a cut-off which can be adjusted through its entire range without stopping the drill. The cards were taken at ⅞, ⅝, ½ and ¼ cut-off respectively, and with due allowance for the difficult conditions, should be considered excellent. In operating a rock drill the imperative thing is not the production of ideal cards or the securing of minute economies in air consumption, but rather the striking of the ideal blow into the rock and the greatest economy of time in rock penetrations. Of this the cards give no evidence either way.



COST OF THE BIG CUNARDERS

These magnificent boats—the finest steamers afloat, the best creation of modern nautical skill and ability—were practically donated to the Cunard Line. Nothing has been spared to make them perfect; nothing has been spared which could render them more swift, more strong, more true, more useful. Nothing has been spared to secure economy of administration, of maintenance, and of operation. These magnificent vessels cost $6,500,000 each. The English Government loaned the money to the Cunard Line—to the company—under terms, and in accordance with agreement, whereby the subsidies paid by the Government meet every payment of interest and principal the moment it becomes due. At the end of twenty years the *Mauretania* and the *Lusitania* will not have cost the Cunard Company one cent. All the Cunard Company has had to do, all the Cunard Company will have to do, is to make a profit over and above the cost of maintenance and operation.—*Speech in Congress of Hon. J. Sloat Fassett.*

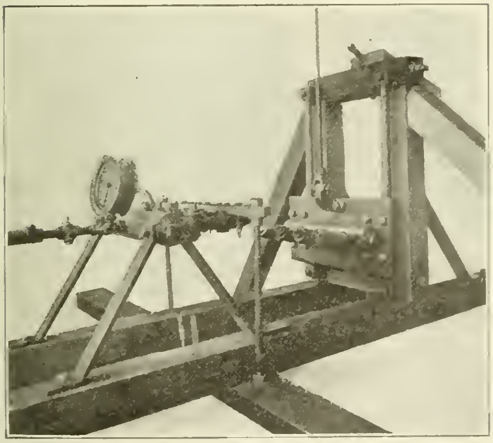


FIG. I.

A HOSE FATIGUE TESTING MACHINE

When the testing of air brake hose is spoken of the first thought naturally is that a pressure test, with an ample factor of safety, is all that could be required. Practice, however, shows that such a test is not sufficient, since hose gives out generally not as the result of dead pressure, but on account of the constant bending to which it is subject on rapidly moving trains. The half-tone Fig. 1 reproduced from the *American Machinist,* shows an apparatus in use in an English shop for testing samples of hose simultaneously both for pressure and for constant bending and kinking. The hose is first tested with water up to 600 lbs., and then samples 20 inches long are attached at one end to the fixed manifold shown and the other to the manifold on the vertically moving crosshead. This crosshead is connected by the rod to a crank overhead and has a travel of 14 inches, making 40 double strokes per minute. The pressure on the hose is kept constantly at 90 lbs.; most samples last 25 hours, while some run as long as 40 hours. The severe kinking which occurs is suggested in Fig. 2.

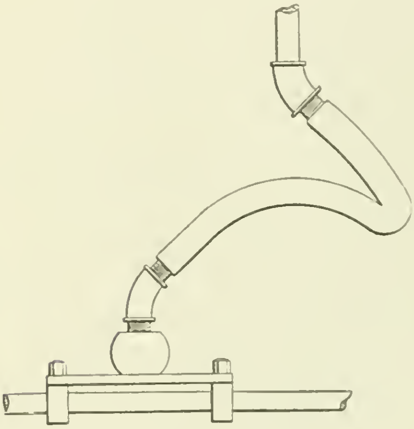


FIG. II.

WATER PUMPED BY ITS OWN GAS

A system of separating natural gas from water is being used to pump water from a large flowing well between Redono and San Pedro, Cal. The well yields a heavy stream of water with much natural gas running through it, and it is this gas which is being transformed into power to drive the engine. The gas and water are separated in a large iron tank, which at its trial sent a considerable volume of gas into the air, while 1,000 gallons per minute of pure water was carried to the reservoir. The gas is carried to the engine by suction. The device is expected to render waste lands productive and add much value to tracts which hitherto have not been irrigated on account of the great quantity of marsh gas in the water strata.

HYGIENIC ECONOMICS

In Bulletin No. 79, of the Bureau of Labor, Frederick L. Hoffman, discusses processes and working conditions in occupations where, because of dust, the employment is injurious to health and leads in particular to the development of consumption.

It is the opinion of the author that by intelligent methods of ventilation and dust removal the consumption death rate among wage-earners can be reduced from 2.2 per 1,000, the rate based on the number of deaths among gainfully employed persons 10 years of age and over in the registration States in 1900, to 1.5 per 1,000, the average rate for 200 small cities, as shown in the mortality statistics of the United States Census for 1901 to 1905. Such a reduction, the author estimates, would result in an annual saving of 22,238 human lives and would add 15.4 years of life for every death from consumption avoided by rational conditions of industrial life. Such a gain would represent a total of 342,465 years of additional lifetime, and by just so much the industrial efficiency of the American nation would be increased. Placing the economic value of a year's lifetime at only $200, the total average economic gain to the nation would be $3,080 for every avoidable death of a wage-earner from consumption, representing the enormous total of $68,493,000 as the aggregate annual financial value in the probable saving in years of adult human life. With such results clearly within the range of practical attainment, nothing within reason should be left undone as a national, state, and individual or social duty to prevent that needless, but now enormous, loss of human life from consumption due to the unfavorable conditions in American industry.

CLEANING BRIDGE STEEL WITH SAND-BLAST

A sand-blast apparatus operated by a compressor driven by a gas engine, was used some time ago in cleaning the bridge across the Mississippi River at Fort Madison, Ia., preparatory to painting it for the first time in 12 years. The total length of the structure is about three-quarters of a mile. The air plant was located on a spur near the western end of the bridge and consisted of a 45-hp. multiplex Otto gasoline engine, an air compressor, a 5x15-ft. receiver, water tank for cooling water, and a gasoline tank. In order to start the large engine a 2-hp. simple Otto gasoline engine was used to raise the pressure in the receiver to 75 or 80 lb., the large engine maintained a pressure of 85 to 100 lb., depending on the number of blasts in operation. The air was taken onto the bridge from the receiver through 1½-in. pipes tapped and plugged every 60 ft. for attachment to the sand drums. The latter were of steel with hemispherical bottoms. The main air line branched at the drum into a large pipe leading into the drum, a ½-in. pipe for carrying the pipe from a vertical branch beneath the drum, and a ½-in. pipe connecting into the blast line beyond the latter point. Connection between the drum and the nozzle was made with 1½-in. reinforced rubber hose, 50 ft. long. The nozzle was a ⅜-in. pipe reduced to a ¼-in. tip. The bridge was cleaned in three months, using three machines. —*Engineering Record.*

STEEL GAS MAINS

The improvements in the production of steel, and its application to the manufacture of solid drawn tubes by the Mannesmann process, leads to an increasing use of this material in place of cast iron for gas mains. The production of steel tubes up to 30 or 40 ft. in length, with the advantages of increased carrying capacity, fewer joints and flexibility, combined with the unbreakable nature of the material, coincides with the need that has arisen to resist the strains put upon pipes by the methods now adopted in the construction of road surfaces and the increased weight of traffic upon them; and these factors have contributed to shake the monopoly so long held by cast-iron pipes for the conveyance of gas and water. One great drawback to the use of light steel pipes for the purpose of distributing gas has been the difficulty of making a sound connection between the service pipe and the main; but improvements have recently been made which promise to remove this trouble. The British Mannesmann Company have introduced a method to accomplish this. By the insertion of strips of metal they increase the gauge on two sides of the tube, resulting in the thickening of the material in the position usually selected for the insertion of the service pipe, sufficient to provide thickness for the number of screw threads requisite to secure a sound joint.

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CHARLES T. PORTER

The John Fritz Medal is awarded annually "for notable scientific or industrial achievement." The recipients thus far have been Lord Kelvin, George Westinghouse, Alexander Graham Bell, Thomas Alva Edison, and now Charles Talbot Porter. The award has been eminently well bestowed in each instance, and, speaking with careful weighing of words, the latest of the recipients of the medal is in no way less entitled to it than any of his illustrious predecessors. The general public knows less of Mr. Porter than of the others, but the engineering world knows him well, although few even here realize the magnitude of their indebtedness to him. The formal award in his case is for his work in the development of the modern high speed engine. He revolutionized steam engineering, and all the later developments of the power house and the special applications of steam in the rolling mill, in marine service, in the vast electric field, and practically wherever steam is employed, were led up to and made possible by him. And all this came not as the result of a single happy thought or of one great invention, but from a changing and adapting and originating of many details, so that in his life work the inventive faculty was constantly alert and resourceful. Not only was the designing and inventing task most exacting, but the high speed requirements created a revolution also in shop practice, and Mr Porter became a pioneer in precise workmanship as it is known to day, not only insisting upon minute accuracy and finish but devising also the ways and the means for such production. While the modern precise methods of manufacture and the almost absolute identity of parts produced cannot be credited to any one or even a dozen men, Mr Porter was among the first and most insistent and successful of modern manufacturers and in his line no more excellent workmanship has ever been achieved. Mr Porter not only thus taught the tricks of high speed and precision, but he stimulated others to notable engineering achievements, and he was just in awarding credit. In the Porter Allen engine he never allowed the Allen element to be overlooked or belittled. He stimulated Chas. B. Richards to produce the high speed indicator, and his book in exposition of it marked an epoch in the profession. All this work brought no wealth, nor even a retiring competency

JASPER R. RAND.

Jasper R. Rand, president of the Rendrock Powder Company and vice president and director of the Ingersoll-Rand Company, died of pneumonia at Salt Lake City, March 30. He was the son of Jasper Raymond Rand of the powder firm of Laflin & Rand and one of the founders of the Rand Drill Company, and nephew of Addison Rand whose life work was in the presidency of that company.

Mr. Rand was born in Montclair, N. J., Sept. 3, 1874, and was graduated from Cornell University in 1898 with the degree of Mechanical Engineer, and the Spanish American War occurring just at that time he saw service in Porto Rico as a member of the First New York Volunteer Engineers. Immediately following that experience, 1899-1900, he was president of the Imperial Engine Company, Painlat Past, N. Y. From 1900 to 1905 he was president of the Rand Drill Company and since

1905 he had been vice president and director of the Ingersoll-Rand Company, this continuing his principal business interest. Besides his presidency of the Rendrock Powder Company, he was connected with the Locke Steel Belt Company and various Western mining operations.

Mr. Rand was a member of the Alpha Delta Phi fraternity, of the Spanish War Veterans, the American Institute of Mining Engineers, American Society of Mechanical Engineers and of the Knollwood, Army and Navy, Alpha Delta Phi and Cornell Clubs, also the Automobile Club of America. His only near surviving relative is a married sister, traveling abroad.

MAJOR ZALINSKI

Major Edmund L. Zalinski, U. S. Army, retired, died at the New York Hospital March 10. He was best known, especially to our readers, as the inventor of the dynamite gun. He was born in Poland in 1849, coming to this country with his parents when four years old, his boyhood being passed in Central New York. From the Syracuse high school he went into the Civil War in his fifteenth year, serving as an aide under Gen. Nelson A. Miles and being mustered out after a year's service as second lieutenant of volunteers. In 1866 he was appointed second lieutenant in the regular army, was first lieutenant in 1867 and captain in 1887, being retired for disability in 1894 and ten years later receiving the rank of major for civil war service.

Zalinski was Professor of Military Science in the Mass. Inst. of Technology from 1872 to 1876, and was graduated from the Artillery School at Fortress Monroe and the Fort Totten School of Submarine Mining in 1880. He traveled under orders in Europe in 1889 and 1890 to obtain special military information.

Most of Major Zalinski's time and thought had been devoted to the pneumatic dynamite gun which, as installed on the special cruiser Vesuvius, was capable of throwing a projectile weighing 1,000 pounds charged with 500 pounds of high explosives. It has never been suggested that any other man could have accomplished more under the hampering conditions, but the device was never a practical success and later developments in the constitution and in the handling of explosives rendered a special gun superfluous. Zalinski invented, also, among other things, an intrenching tool, a ramrod bayonet, a telescopic sight for artillery and a system of range and position finding for seacoast artillery firing. Major Zalinski in recent years resided in New York, and he was a member of the Century, Union League, Lotus and Engineers' Clubs.

TRADE PUBLICATIONS

Instructions for the Use of Thermit in Railroad Shops. Goldschmidt Thermit Company, 36 pages 6x9 inches. This is a revised edition of "Shop Instructions for the Use of Thermit in Repair Work," and it treats the matter very completely both in text and illustrations.

The Sprague Electric Company, New York, is sending out an attractive fan catalogue for 1909. It contains both direct and alternating current fans for desk, wall, ceiling, floor and counter column uses. Special attention is called to the new direct current oscillating desk and bracket fan on account of its simplicity and durability, and also to the fact that the oscillator mechanism can readily be attached to Lundell non-oscillating fans of the 1909 type.

NOTES

The maximum temperature allowed by law in underground stopes in Victoria, Australia, is 83 deg. F.

It costs less than four per cent. more in heat units to make a pound of steam at 150 pounds than to make it at atmospheric pressure.

The older the mine the more dangerous it it, so far as explosions are concerned. This is especially true where mines penetrate the earth to a considerable depth, and it does not matter whether the coal is reached by drift, slope or shaft opening.

An optimist has been likened unto a tea kettle which whistles loudest when it is in hot water up to its neck

Cost of power per horse-power year, developed electrically by turbine water-wheels, ranges from $6 to $23 at various Eastern plants It is sold at $13 at Niagara; at Lawrence, Massachusetts, it costs about $20, with a 1,000-hp. installation. The average cost of steam-power would not exceed 0.8c. per horsepower hour.

The Kaieteur fall in British Guiana is said to be five times as high as Niagara and almost twice as high as the Victoria falls of the Zambesi.

Dr. Carroll D. Wright, president of Clark College and once U. S. Commissioner of Labor, whose death occurred recently, was in the early stages of his business career a patent attorney, and secured for T. A. Edison his first patent, that for a vote recorder.

Recent experiments show that ⅓ oz. of coal dust per 35 cu. ft. of air will suffice for the production of an explosion. It was also found that it is more a question of fineness of the division of the dust than the weight, that causes a condition of great danger.

Record-breaking progress is being made at the Cripple Creek Deep Drainage Tunnel. Between March 1 and 17, 476 ft. was gained. The distance from the portal to the first heading is now 5,383 ft., and from the foot of the intermediate shaft a total of 1,552 ft. has been driven.

A company has been formed in New York to manufacture flying-machines so that they can be sold for seventy-five hundred dollars; but a "glider with a catapult for launching" is offered for six hundred dollars. The cheaper device may serve to develop customers for the full-fledged machines.

A wider investigation of the pneumatic firebox door closer and the mechanical stoker should be made, because the steady increase in the size of power will in all probability necessitate the adoption of some such devices in the interests of economy and of the firemen. —*Report of Committee, Traveling Engineers' Association.*

What is declared will be the first town of exclusive concrete construction in the world is to be established at Metaline, Wash., in the heart of a lead mining district of the same name, 105 miles north of Spokane, by the Lehigh Valley Cement Company, of Pennsylvania, which has immense cement deposits nearby.

W. L. Saunders, president of the Ingersoll-Rand Company has been appointed a member of a special committee of the Chamber of Commerce of the State of New York to prepare a report on the Panama Canal. The committee will probably review the findings of several engineers on the question of the merits of a sea level canal as against a lock canal, and will investigate the advantages of the canal to American commerce and benefits to be derived from the canal in the future.

News comes from Liverpool that Sir Oliver Lodge recently succeeded in completely clearing away for a radius of 60 feet a thick fog by means of electrical discharges. The Marine *Journal* states that the Lodge system consists of driving electricity into a fog-laden atmosphere at a very high voltage from a series of disks at the tops of poles. The current acts directly upon the constituents of the fog, the electric influence whirling these hither and thither, causing them gradually to fall to the ground.

David Matheson, whose home is in Tacoma, Wash., a contractor in active business, has, as the result of accident, neither hands nor feet. He has just completed a large contract for the C. M. & St. P. Railroad, the work being on the western foothills of the Cascade Mountains, where immense masses of rock were to be blasted and carried to fill deep ravines. He personally oversaw and directed the work of cutting roads and establishing camps, and for two and a half years the work was carried on under his direct supervision.

The Richmond, Fredericksburg & Potomac Railroad Co., which is now operating its gravel washing plant near Fredericksburg, Va., to secure a roadbed ballast without dust, has now laid about 15 miles of line with new ballast, which, according to an official statement, proves extremely satisfactory, as it not only entirely prevents dust, but presents a very attractive appearance.

The first attempt at pneumatic separation of ores appears to have been made about 1828, but without success, and very little more was done until Krom brought out his air-jig in 1868; this found application in a few isolated cases, and from that time to the present machines for pneumatic separation have been brought out periodically, but none has yet secured for itself a permanent hold upon the art of ore-dressing.

Isle Royale, close to the Canadian shore of Lake Superior but a part of the State of Michigan, the largest fresh water island in the world, comprising some 85,000 acres, has just been purchased by American interests from an English syndicate which owned it for many years. The deal was concluded by F. W. Nichols of Houghton and Oscar J. Larson of Duluth, the latter the agent of the United States Steel Corporation.

In Victoria, Australia, the government has specified the following antidote for cyanide poisoning to be hung in some easily accessible place in the mill: A hermetically sealed bottle containing 7½ grams ferrous sulphate dissolved in 30 c.c. water; a bottle containing 1½ grams caustic soda, dissolved in 300 c.c. water; and a tube containing 3 grams of magnesia. The ingredients are to be mixed and introduced into the patient's stomach through a rubber tube which acts as a siphon for emptying the stomach of its poison.

Pure hydrogen manufactured with a simple apparatus and from non-bulky materials, is the achievement of recent French experiments. Fine aluminum filings are mixed with a small proportion of mercuric chloride and potassium cyanide, which causes a slight rise of temperature, and produces a coarse powder, quite stable if kept dry. This powder is treated with water, about a pint to a pound, and the temperature, as the hydrogen is evolved, is kept below 160° F. by the addition of more water. At that temperature 2¼ lb. is completely oxidized in two hours, and yields 44 cu. ft. of pure hydrogen.

Zapote is a Mexican wood which grows to great size. Although the wood of this tree has considerable value for lumber, it is seldom used in that way, but is cherished as the producer of chicle, the sap which forms the basis for many chewing gums. The wood of zapote is dark red, and easily worked until it becomes thoroughly seasoned, when only the finest edged tools have any effect upon it; it sinks in water like a piece of iron. The wood takes a magnificent finish, as do nearly all the native varieties, and would be a fine medium for cabinet-making.

Nearly all wells less than twenty-five feet in depth yield water that is unfit for use, according to the general report of the State Water Survey recently issued as University of Illinois Bulletin, State Water Survey, series No. 6. Of the 868 well waters examined during the year, 60 per cent. were condemned; 85 per cent. of the wells less than twenty-five feet in depth were condemned, while only 13 per cent. of those more than 100 feet in depth were found unusable, and the deep wells were usually condemned because of the excess of mineral matter, and not because pollution by sewage was suspected.

The extraordinary power of hot silica bearing water to penetrate and microscopically replace certain substances with the utmost minuteness and faithfulness is shown in some of the deep and old abandoned workings of the Comstock mine, where not only have the timbers been partially silicified by the hot, silicious waters, but even the fine, soft, impalpable fungus growing on those timbers, and well known to miners in the timbering of damp portions of mines, is replaced by opaline silica down to the minutest fiber and showing the delicate, fernlike patterns of this parasitic growth.

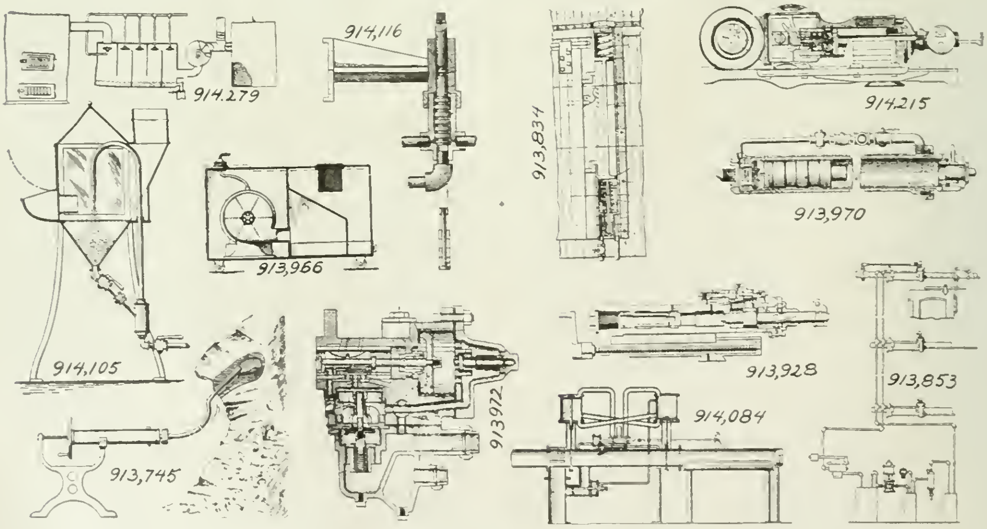
The best way to get a good object lesson on the full benefits of a good blower and dust-collector system, is to go into a wood-working plant where there is an excellent system, then go into another where there is none or where the system is faulty. There will not only be a striking difference in the general appearance, with trashy accumulations around machines where there is no collector system, but there will be a difference in the appearance of the work itself. From which it is easy to understand that a good blower system is well worth while.—*Wood-Worker.*

As far as pumping water is concerned, a centrifugal pump can take its suction from almost a perfect vacuum, but since it is a complete failure as an air pump, a very small quantity of air in the suction under these conditions will cause it to cease pumping completely. Since the volume of any given quantity of air increases with the vacuum, and the leakage also similarly increases, the probability that air in the suction will cause trouble increases about as the square of the suction lift. If in addition to a high lift, the suction pipe is long and perhaps old, trouble can be predicted to a certainty. In view of these conditions, a 20-foot suction lift, including friction, should be about the maximum.

The government's new forest products' laboratory will be located at the University of Wisconsin. The establishment of the laboratory means the concentration of all the lines of experimental investigation of the government looking to closer and better utilization of timber and the checking of wood waste. Forest Service laboratories for timber test work at Yale and Purdue Universities and the government's wood pulp and wood chemistry laboratory in Washington will be consolidated and transferred to Madison as soon as practicable. A force of fifteen to twenty timber test engineers, experts in wood preservation, wood pulp manufacture and wood distillation will have charge of the work carried on.

The pressure of inclined rock strata in the Townes tunnel on the Carolina, Clinchfield & Ohio Ry. was greater than could be borne safely by a plain concrete lining, and therefore steel reinforcement ribs were used. These ribs are 12-in. I-beams, spaced on varying centers, from a minimum of 1 ft. to a maximum of 34 ft., depending on the pressure. Since the pressure came from one direction, the I-beams were placed on one side only, and around the arch. The side beams were given a convex curve against the pressure, and their feet were skewed to give bearing for the thrust. The concrete lining was used to an angle of 30 deg. above the springing line, and the arch finished in brick.

There is now an air tight milk can which may be filled at the dairy, hermetically sealed, and kept in this condition until the entire contents of the can are removed at the place of sale. This result is effected by the use of compressed air in the can, which forces out the contents, as needed. The compressed air is sterilized, and everything about the milk is kept perfectly clean. There is no danger from contamination by exposure to dust and dirt or flies and other insects. It is impossible to change or adulterate the contents of the can in any way from the time it leaves the dairy until the contents have been placed in the consumers' hands. The can is locked, and no liquid can be pumped into it without breaking the lock and removing the cover.



Pneumatic Patents, March 2.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

MARCH 2.

913,745. MACHINE FOR FIXING BLASTING CHARGES. Oliver F. Malcolm, Joplin, Mo.

913,834. AIR-CONTROLLED LOCK FOR SLIDING DOORS. William J. Martin, Buffalo, N. Y.

913,853. PNEUMATIC OPERATING MECHANISM FOR DOORS OR OTHER DEVICES. Harold Rowntree, Chicago, Ill.

913,928. ROCK-DRILL. John A. Traylor, Denver, Colo.

913,932. ROCK-DRILL. Thomas E. Adams, Cleveland, Ohio.

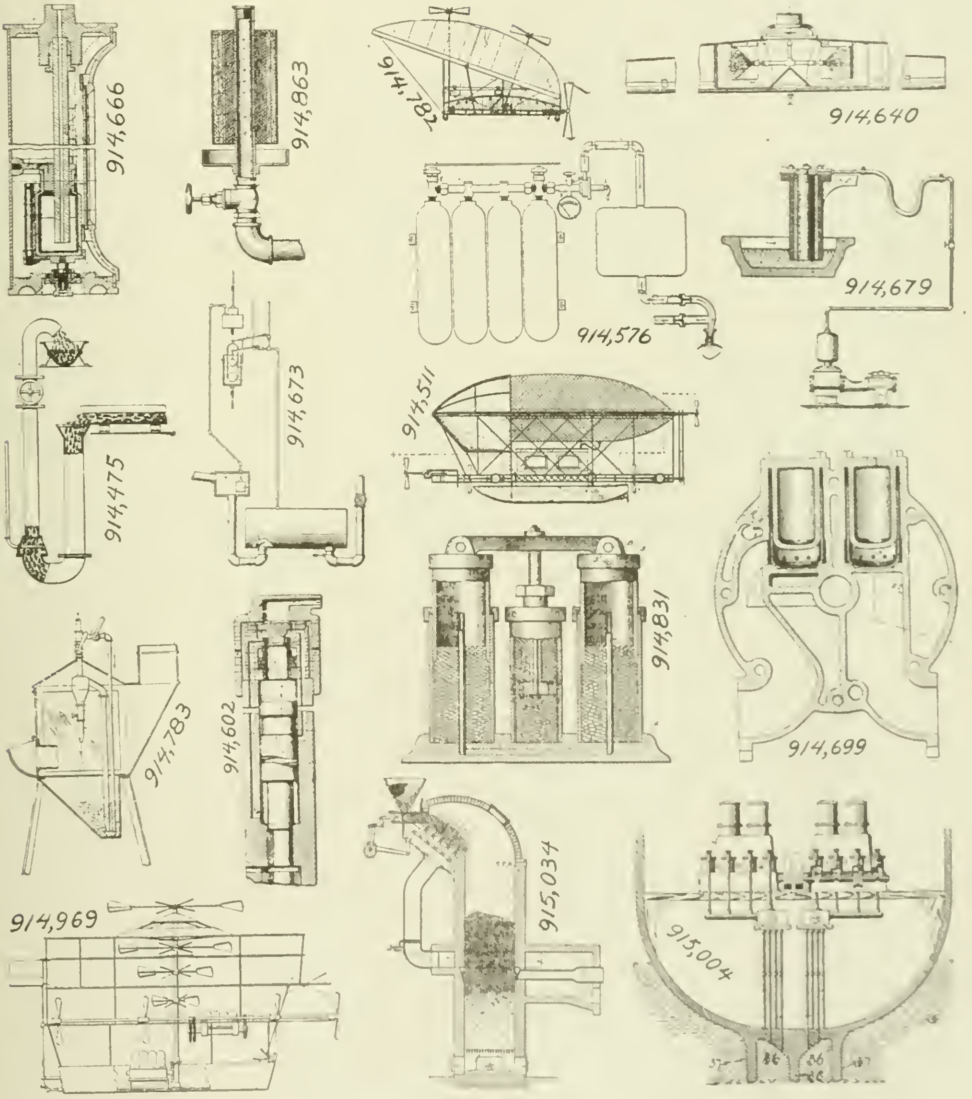
913,966. SUCTION-CLEANER. Otto H. Mohr, San Francisco, Cal.

913,970. FLUID-PRESSURE RAM. Alfred Parfitt, Topeka, Kans.

914,084. PNEUMATIC-DESPATCH-TUBE APPARATUS. Charles F. Stoddard, Boston, Mass.

914,105. SAND-BLAST MACHINE. Francis P. Boland, Providence, R. I.

914,116. GOVERNOR FOR AIR-COMPRESSORS. Eli B. Coup, McKeesport, Pa.



Pneumatic Patents, March 9.

914,215. ROCK-DRILL. Thomas E. Adams, Cleveland, Ohio.

914,279. PROCESS OF OBTAINING NITROGEN FROM AIR. Oliver P. Hurford, Chicago, Ill.

MARCH 9.

914,463. PNEUMATICALLY-OPERATED DEVICE. Willard C. Smith, Kankakee, Ill.

914,475. APPARATUS FOR ELEVATING AND CLEANING MATERIAL OF A GRANULAR NATURE. Franz Beduwe, Luttich, Belgium.

1. In apparatus for elevating and cleaning granular material the combination of a conduit having an upwardly and a downwardly directed portion, means for introducing the granular material after admixture with a liquid into the downwardly directed portion of the conduit, a compressed air distributing device in the lower end of the upwardly directed portion of the conduit and a receiver adjacent to the upper end of this conduit for the material and liquid as they are discharged therefrom by the air lift as set forth.

914,511. AIR-SHIP. Joel T. Rice, Hot Springs, Ark.

914,737. ROCK-DRILLING ENGINE. John G. Leyner, Denver, Colo.

914,782. AEROPLANE AIR-SHIP. Louis A. Becht, Paris, France.

914,783. SAND-BLAST MACHINE. Francis P. Boland, Providence, R. I.

914,831. PNEUMATIC BUFFER FOR SELF-PROPELLED VEHICLES. Melville P. Hayward, Quincy, Mass.

914,863. AIR-MOISTENER. Charles G. McKendrick, Monroe, N. Y.

914,969. AEROPLANE. Henry Mueller, St. Louis, Mo.

915,004. PNEUMATIC PROPULSION OF VESSELS. Edward Wilde, Philadelphia, Pa.

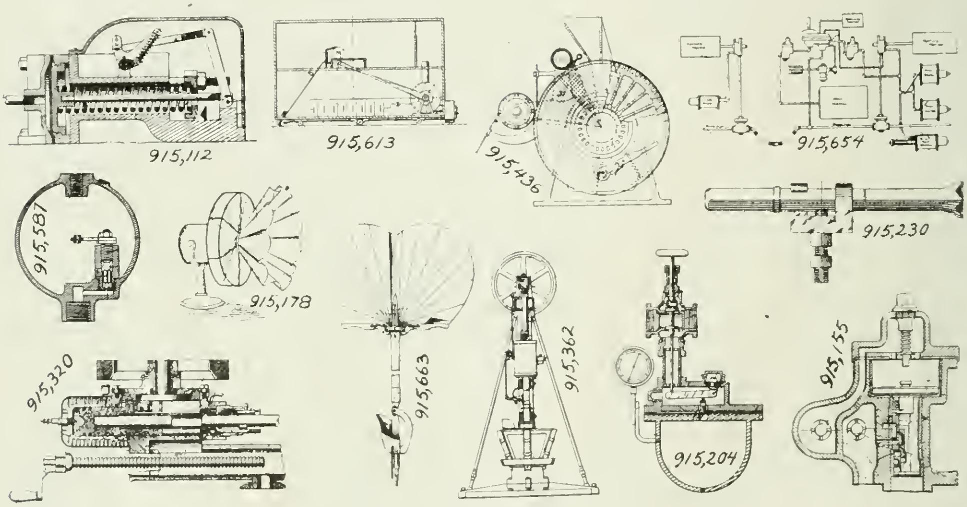
915,034. PROCESS OF GENERATING GAS. Charles E. Lucke, New York, N. Y.

MARCH 16.

915,112. ELECTRIC AND PNEUMATIC GOVERNOR. William K. Rankin, Philadelphia, Pa.

915,155. AIR-BRAKE APPARATUS. Henry F. Bickel, New York, N. Y.

915,178. ELECTRIC-FAN AIR-SPREADER. Newton S. Hillyard, St. Joseph, Mo.



Pneumatic Patents, March 16

914,576. RESPIRATOR. George F. Jaubert, Paris, France.

914,602. FLUID-PRESSURE TOOL. Fridolin Polzer, New York, N. Y.

914,636. ROTARY TUNNELING-MACHINE. Charles A. Case, New York, N. Y.

914,640. HUMIDIFYING AND AIR-CONDITIONING APPARATUS. Stuart W. Cramer, Charlotte, N. C.

914,666. VACUUM-GAGE. Henry W. Maurer, Rochester, N. Y.

914,673. APPARATUS FOR CONTROLLING THE APPLICATION AND RELIEF OF PRESSURE TO TANKS AND OTHER APPLIANCES. Albert Priestman, Philadelphia, Pa.

914,679. PROCESS FOR CASTING METALS. Martin V. Smith, New York, N. Y.

1. The herein described process of applying to a core of one metal an outer shell of another metal which consists in mounting the core in a mold, exhausting the air from the mold and the surface of the core, and causing the other metal to flow into the mold around the core in the same direction the air flows therefrom.

914,699. COMPRESSOR-VALVE. Niels A. Christensen, Milwaukee, Wis.

915,204. PRESSURE-REGULATOR. Thomas Montgomery, Sarnia, Ontario, Canada.

1. In automatic regulating devices for fan engines and the like, the combination with the main air reservoir filled with air at a predetermined pressure and hermetically sealed and provided with a top having an orifice therein and a flat outer surface, of a diaphragm lying normally parallel with the surface, a supplemental top having an inner surface parallel to the plane of the outer surface of the top, packing rings holding said diaphragm normally midway and parallel to the outer surface of the top and inner surface of the supplemental top, the supplemental top being provided with a central orifice and an outer chamber located and communicating with the steam line, a valve in the steam line and means between the valve and the diaphragm operated from the diaphragm for adjusting the position of the valve as and for the purpose specified.

915,230. WATER ATTACHMENT FOR DRILL-STEELS. James H. Sinclair and Guy D. Neill, Denver, Colo.

915,320. GASOLENE-OPERATING ROCK-DRILLING ENGINE. Rolland S. Trott, Denver, Colo.

915,362. ATMOSPHERIC STAMP. Charles H. Krause, Keweenaw Bay, Mich.

915,366. AUTOMATIC PENUMATIC PIANO. Axel F. Larson and Karl O. Ostergren, Chicago, Ill.

915,436. VACUUM DRUM-FILTER FOR SEPARATING SOLID SUBSTANCES FROM LIQUIDS. Heinrich Hencke, Charlottenburg, Germany.

915,587. PRESSURE-REGULATING DEVICE FOR GAS AND STEAM. Auguste Gaudet, Paris, France.

915,613. PNEUMATIC SWEEPER. William P. Leister, Cliffside, N. C.

915,654. AIR-BRAKE SYSTEM. John S. Barner, Albany, N. Y.

915,663. FAN. Ferdinand D'Aversa, New York, N. Y.

MARCH 23

915,723. AIR-BRAKE TRIPLE VALVE. Walter M. Austin, Swissvale, Pa.

915,724. FLUID-PRESSURE AIR-BRAKE. Walter M. Austin, Swissvale, Pa.

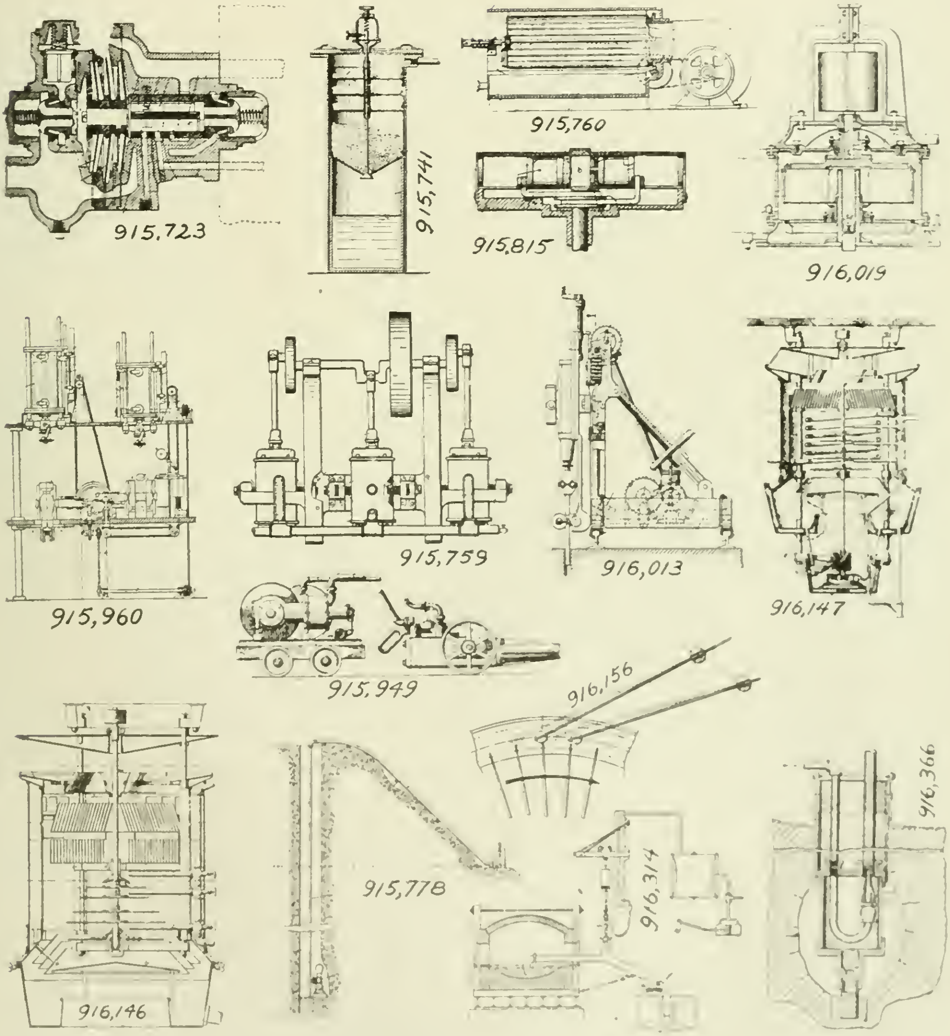
915,735. HANDLE-LOCK FOR PNEUMATIC TOOLS. George L. Brown, Louisville, Ky.

915,741. APPARATUS FOR OPERATING RAILWAY-SIGNALS. Clyde J. Coleman, New York, N. Y.

915,759. AIR-COMPRESSOR. Gerald Foll, Winnipeg, Manitoba, Canada.

915,760. APPARATUS FOR REGENERATING AIR. Richard von Foregger, New York, N. Y.

915,778. WATER-ELEVATING APPARATUS. James S. Lawrence, San Javler Mexico.



Pneumatic Patents, March 23.

915,813. MOTIVE-FLUID-OPERATING TOOL. Daniel S. Waugh, Denver, Colo.

915,815. AIR-COMPRESSOR. Henry Wilcox and Frank Brabson, Newark, N. J.

915,949. MINING MACHINERY. Arthur H. Gibson, Easton, Pa.

915,950. PULSATOR. Arthur H. Gibson, Easton, Pa.

915,960. GLASS-BLOWING MACHINE. Hermann Hilde, Rosswein, Germany.

916,013. CHANNELING-MACHINE. William Prellwitz, Easton, Pa.

916,019. METHOD OR PROCESS OF COMPRESSING AIR. William K. Richardson, Leavenworth, Kans.

916,114. FLUID-PRESSURE CUT-OFF. Rex Davis, Salem, W. Va.

916,146. MACHINE FOR HUMIDIFYING AND CLEANSING AIR AND CONTROLLING ITS TEMPERATURE. Daniel P. Gosline, Boston, Mass.

916,147. MACHINE FOR CONDITIONING AIR. Daniel P. Gosline, Boston, Mass.

916,156. QUANTITY-REGULATING DEVICE FOR ROTARY FLUID-COMPRESSORS. Albert Huguenin, Zurich, Switzerland.

916,314. PNEUMATIC APPARATUS FOR DISCHARGING FURNACES. Samuel E. Hitt, Pittsburg, Pa.

916,366. EJECTOR FOR OIL-WELLS. James W. Plimpton, Oil City, Pa.

MARCH 30.

916,456. AIR-SHIP. Oscar J. Laisy, Cleveland, Ohio.

916,463. FLUID-PRESSURE ENGINE. William T. Lewis, Columbus, Ohio.

916,567. FRESH-AIR-TREATMENT APPARATUS. Lawrence P. Leonard, St. Cloud, Minn.

916,644. PNEUMATIC RAIL-BRAKE. Powell O. Adams, Cameron, Tex.

916,669. RETAINING-VALVE FOR AUTOMATIC AIR-BRAKES. John M. Carter, Memphis, Tenn.

916,703. ROCK-DRILL. Benjamin Hastings, Cleveland, Ohio.

1. The combination with a piston hammer drill, of a drill bit whose diameter of cut is wider than the largest outside diameter of said piston hammer drill, said piston hammer drill being adapted for entrance into the hole made by it, substantially as described.

916,713. PNEUMATIC PIANO-PLAYER ACTION. Giovanni M. de Julio, New York, N. Y.

916,726. POWER-FLUID GENERATOR. Christopher John Lake, Bridgeport Conn.

1. The combination in a power fluid generator of two generating chambers; and apparatus for charging one chamber with air and a hydrocarbon and the other chamber with air and water, said apparatus being driven by pressure derived alternately from each chamber when charging the other chamber.

916,737. DEVICE FOR CONTROLLING AIR-BRAKES OF RAILWAY-VEHICLES AND ELECTROMOTIVE ENGINES. Jacob M. Long, Los Angeles, Cal.

916,738. SWITCH - OPERATING DEVICE. Thomas H. Lord, Altoona, Pa.

916,764. PNEUMATIC PIANO. August Nordeen, Newcastle, Ind.

916,765. PNEUMATIC PIANO. August Nordeen, Newcastle, Ind.

916,808. SPRAYER. Henry A. Voelkner, Detroit, Mich.

916,857. AIR-COMPRESSOR. Lewis A. Gates, Oroville, Cal.

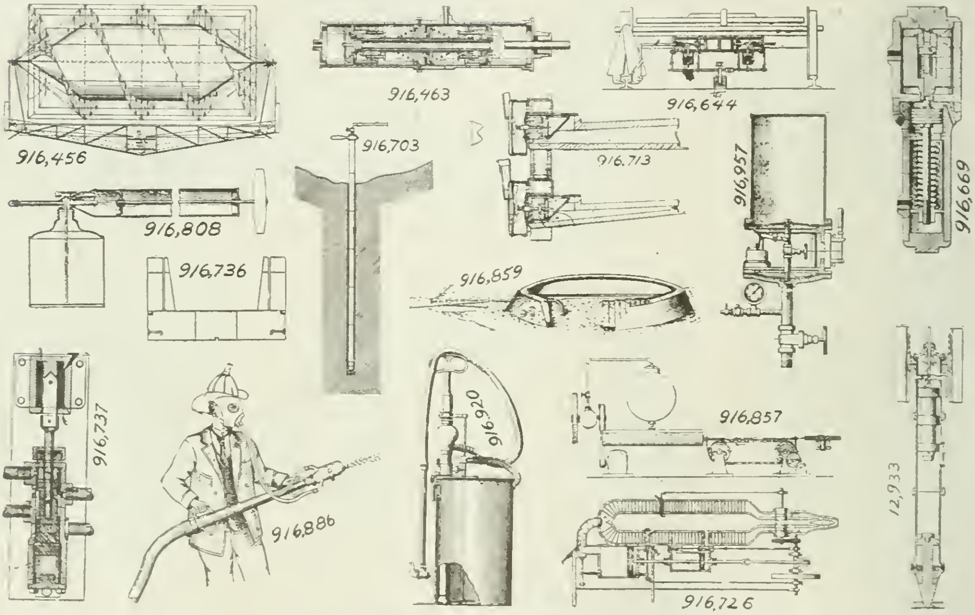
916,859. APPARATUS FOR MINING GOLD AT THE BOTTOMS OF FLOWING STREAMS. Leander F. Gilman, Sacramento, Cal.

916,886. AIR-ACCUMULATOR. William F. Merryman, Denver, Colo.

916,920. TANK AND SPRAY PUMP. William L. Deming, Salem, Ohio.

916,957. PRESSURE-REGULATOR. Augustus C. Durdin, Jr., Chicago, Ill.

12,933. SUBAQUEOUS ROCK - BREAKER. Charles L. Rowland, New York, N. Y. (Reissue.)



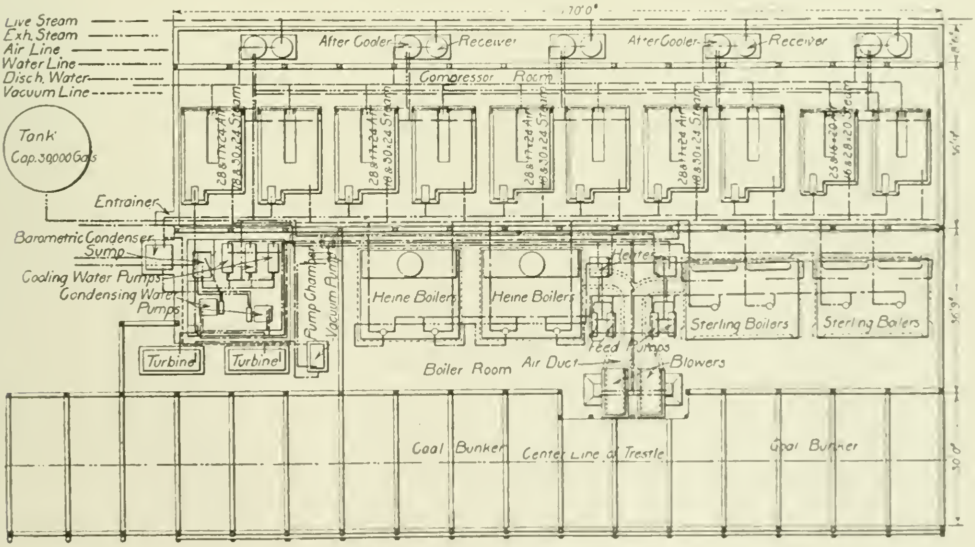
Pneumatic Patents, March 30.

COMPRESSED AIR
MAGAZINE
EVERYTHING PNEUMATIC.

Vol. XIV JUNE, 1909 No. 6

COMPRESSED AIR FOR THE RONDOUT SIPHON

One of the most important contracts on the Catskill Aqueduct work for increasing the New York water supply is that for constructing the Rondout siphon, near High Falls, Ulster county, N. Y. This was awarded to the T. A. Gillespie Company of New York, whose bid of $6,290,803.50 was the lowest.



GENERAL LAYOUT OF POWER PLANT.

There are three different types of aqueduct construction included in the contract: pressure tunnel, tunnel on the hydraulic gradient and aqueduct in open cut. The pressure tunnel siphon is 4.5 miles long. It is being driven from eight shafts which range in depth from 374 to 710 feet. The tunnel on the hydraulic gradient has a total length of about 7,000 feet, while the cut and cover aqueduct amounts to only a few hundred feet. The time allowed for the contract is 4½ years. The whole work covers a stretch of country some five miles long, and among the more important quantities estimated are: 4,150 feet of shaft, 27,000 feet of tunnel and 143,000 cubic yards of concrete

sively for the operation of machinery, including drills, hoists, pumps, grouting apparatus, pneumatic tools and other small machines, so that the methods of obtaining and delivering this power are of the first importance. The work will be in progress so long that the daily

Compressed air will be used almost exclu-cost of maintenance and operation of plant were given as serious consideration as was the first cost of machinery and equipment. One large central plant was determined upon for the entire work. Although the first cost of the plant which the Gillespie Company has installed is large, it is believed that in the long run the expense will be amply repaid by the low operating costs and the more satisfactory progress of the work as a whole.

High Falls, on the Kingston division of the New York, Ontario & Western Railway, is the station nearest to the site of the work. A location for the power house was secured on the banks of Rondout Creek between shafts 4 and 5, about half a mile from the High Falls station, easily accessible from the railway line with a supply of good water near.

The power house is a wooden building about 82x170 ft., and rests on concrete foundations. A direct connection between the railway and the plant has been established by a spur track 3 000 ft. long. There are turnouts to store houses and a lumber yard. The spur track terminates at the station in a wooden trestle 500 ft. long, which crosses a highway and reaches the power house at a sufficient elevation to drop the coal into the bunkers. The contractor has also erected a machine shop, cement storehouses, an administrative office, a 200-ft. Howe truss bridge over Rondout Creek for carrying the air line and for transportation purposes, telephone lines, and has built a compressed air pipe line about 5 miles long, 12 in. in diameter at the power house and 8 in. at the farther ends of the line, besides constructing a number of new roads and repairing old ones.

The plant has four 250-hp. Stirling boilers and two batteries of Heine boilers, each of a capacity of 375 hp. The waste gases are carried off through six guyed stacks, one for each Stirling boiler and the other two for the Heine batteries. No. 3 buckwheat coal is used, hand fired. The ashes are removed in wheelbarrows, dumped outside and used for road building. Forced draft is furnished by two blowers, under the Acme control system. The engines for the blowers are built by the American Blower Company. The feed water is taken from the creek through a 24-in. vitrified pipe and delivered by four Buffalo pumps to the boilers. It is warmed by two Cochrane feed-water heaters.

The boilers furnish steam through a 12-in. header to ten high-pressure, high-speed cross-compound air compressors. The steam piping arrangements and the introduction of valves at numerous points permit the cutting out of any number of units in case of accident, without interfering in any way with the others. All compressors are Ingersoll-Rand Imperial type 10 Corliss machines, mounted on concrete beds. Their combined capacity is about 24,000 cu. ft. of free air per minute. Two of the compressors have a 20-in. stroke, with air and steam cylinder dimensions of 15 and 25 in. and 16 and 28 in. respectively, with an air capacity of 1,700 cu. ft. of free air per minute each; the other eight have a 24-in. stroke and air and steam cylinder dimensions of 17 and 28 in. and 18 and 30 in., with an air capacity of 2,400 cu ft. each. The low pressure air varies between 30 and 35 lb. per square inch, and is raised on the high-pressure side to 110 lb. per square inch, the working pressure at the ends of the lines being only about three pounds less than this.

The air cylinders are water-jacketed and the cooling system operated by three Deane pumps having a capacity of 500 gal. each. Only two of these pumps are used ordinarily, the third being held in readiness in case of breakdown. The cooling water is pumped into a 10-in. pipe fitted with a 6-in. branch line which leads to a 30,000-gal. tank. Water is pumped direct into the main lines, the surplus going through the 6-in. branch into the tank, from which a circulation by gravity can be secured. The water is wasted into the creek from the compressors. The jacket water is discharged openly into funnels placed in conspicuous places above the air cylinders, so that the flow can be observed readily. If for any reason the cooling system fails to operate, the stoppage of the flow of water into the funnels indicates this fact, so that the trouble can be remedied or the engine stopped before the cylinders become excessively hot.

The cooling of the air takes place in both an intercooler between the low and the high pressure cylinders of each compressor and also in an aftercooler connected with each pair of machines. From each aftercooler the air enters an air receiver close to it and then passes into the pipe line. The piping and valves between compressors, intercoolers and receivers, as is the case with the steam connections between the boilers and the compressors, are so arranged that should one aftercooler be disabled or require cleaning or other attention the air from the two compressor units which feed into it can be at once diverted into the adjoining coolers.

The use of the aftercoolers in connection with the receivers is a commendable and a profitable, but hitherto an unusual, refinement of practice. The thorough cooling of the air thus accomplished enables it to drop its surplus of moisture in the receiver, which it would not do if it passed through the receiver hot, so that later choking of pipes or freezing up of exhaust passages in the drills or elsewhere is avoided. The complete cooling of the air at the beginning also reduces its volume and consequently makes an appreciable difference in the maintenance of flow in the lines before the work is reached.

The pipe line is buried for its entire length, except at Rondout creek, where it is carried across on the bridge previously mentioned. The air line at the power house, and for the greater part of its length is 12 in. in diameter. The 12 in. pipe extends in a general north and south direction from the central plant as far as shafts 3 and 6, respectively. Here the size is reduced to 10 in. These 10-in. lines feed air to shafts 1 and 2 on the north end and 7 and 8 at the south. Throughout its entire length the pipe line is fitted with the Dresser joint. With it there are no abrupt changes in direction, as is often the case when ells or other fittings are used, and the comparatively low drop in pressure along the line is attributed in some measure to its use. The pipe on the bridge is encased in a wooden box.

The condensing equipment at the station is of the barometric type, and gives a vacuum of about 27 in., and 30 in. when the air pump connected with it is run. The hot condenser water is turned into the creek, as plenty of good boiler water is available, and the use of the hot water would necessitate the installation of oil separators. The air pump is generally used only in starting up, and is stopped when the condenser has reached its normal working order. The condenser water is supplied by two Wheeler centrifugal pumps, each of 3,500 gal. capacity.

At each shaft there is a reheater having a capacity of 1,200 cu. ft. of air per minute. It consists of an outer and inner shell, with an annular air space between, around which the air circulates. A coke oven is placed within the inner shell, heating the air and effecting a gain in efficiency of about 30 per cent.

The central plant runs continuously night and day, and is operated by a force working three eight-hour shifts. The work is well started. Several of the eight shafts have reached grade, headings have been turned and the driving of the pressure tunnel begun.

Mr. Robert A. Shailer is managing engineer on this contract for the Gillespie Company, and Mr. W. L. Canniff has been in charge of building the compressor plant.

The above account is abstracted, with slight interpolations of our own, from *The Engineering Record*.

CARE OF PNEUMATIC CARVING TOOLS

The life of a pneumatic carving tool, as well as its efficiency and satisfaction giving qualities during its life, is fully as dependent upon the care given it as upon the work it has to perform, and a little attention devoted to keeping it in proper condition will pay many times over for the slight trouble involved.

The highly polished, accurately fitted surfaces of the working parts of a pneumatic tool are particularly susceptible to the action of rust, caused by dampness when not in use, and a tool should not be laid away, even over night, without the precaution being taken of dropping a few drops of oil into the inlet, connecting to the hose again and running the tool for a second, so that the oil will be carried through by the air and form a thin film on the internal working parts.

A much better plan, however, is to have a tank large enough to hold all the tools in use filled with kerosene or gasoline, and when the tools are not in use keep them immersed in the oil. This serves a double purpose: the tools are kept from rusting and the gasoline or kerosene cuts and softens any deposit of oil and dirt in the air passages of the tool that may come from the compressor. The tool in the morning should be connected with the hose and thoroughly blown out, then disconnected, a little oil (just a few drops) used then connect up and go ahead. A few drops of oil should be inserted at intervals of a couple of hours through the day. Use a light, limpid mineral oil, and on no account whatever use an animal oil, such as lard oil, sperm, etc., as the tendency of these oils is to gum and clog up the air passages.

We have had many tools sent in for repairs with the complaint that they had lost their power, when the trouble lay in some, or all, of the air passages being almost entirely closed up by gummy oil, which had either been used in the tool, or had come through the pipes and hose from the compressor. The practice of keeping the tools in an oil tank will entirely overcome this trouble.

If a carving tool refuses to run, the trouble almost invariably will be that the piston or inside of the barrel has become roughened by a bit of grit, and the remedy for this is to take the tool apart and with a piece of fine emery or crocus cloth rub the abraded part of the piston smooth. It more often happens that the piston is roughened than the barrel. If it is found that the barrel also has suffered, whittle a stick to about the radius of the hole and with the emery cloth carefully smooth out the rough place. Then dip the tool in kerosene, blow out thoroughly with the air hose, put together and it will generally be found to operate satisfactorily.

A piece of this fine emery cloth should always be kept on hand for these emergencies, and if you cannot procure it at your local hardware store, write us and we will send you a sheet free of charge.

Never on any account allow a piston to be put on a grindstone to smooth down a rough spot, as the chances are that the piston will be ruined. [This is an awful suggestion. Ed. C. A.]

We urgently recommend that in all plants particular attention should be paid to the suction of the compressor. Air should never be taken from a room where stone-cutting is being done, as the air is filled with fine particles of grit, which are, in a case of this kind, constantly being drawn into the compressor and forced through the tools, with a consequent continuous grinding or cutting action. The ideal arrangement for a compressor suction pipe is to run it out through the roof of the shed and inclose the end of it in a framework two or three feet square, covered with a couple of thicknesses of fine muslin. When the plant is being installed, nothing but new, clean pipe should be used for conveying air to the tools, and every piece of pipe should be stood on end and hammered to jar loose any scale that may be on the inside, and every fitting should be inspected to see that it is perfectly clean. If old, rusty pipes and fittings have been used, you will have endless trouble and annoyances from dirt and scale coming through the pipes and hose to your tools. These precautions will give you a supply of cool, clean air, and the effective working life of a plant will be increased 100 per cent. over what it will be if installed and operated in the slipshod slovenly manner that many plants are.

The chisels used in carving tools should always receive constant and careful attention. The upper end of the bushing in the tool is provided with a shoulder, which acts as a stop for the end of the chisel shank, and the piston is proportioned as to length, so that when it comes down and strikes a chisel held up against this shoulder, the exhaust ports in the upper end of the barrel are opened just the proper amount to allow the air to escape from the upper end and the piston to make a full return stroke. Therefore, it is obvious that the shanks of the chisels should be kept ground square on the end and full size up to the end. If they are dubbed off at the end, or are so small that they pass up at all above this shoulder, they will prevent the piston from making the full downward stroke, the air pressure at the upper end will not be relieved, and the complaint will be made that the tool has lost its power. After long continued use the shoulder of the bushing will gradually be worn so that it lets the chisel up too far, and the same result of loss of power will be observed, but in this case it is better to send the tool in to the shop for adjustment and repair.

This matter of keeping chisels ground perfectly square on the end is important from another standpoint. When a chisel shank is round or not square on the end, the impact of the blow is not distributed over the entire striking surface of the piston as it should be, but is concentrated in one particular spot with a consequent extreme liability of fracturing the end of the piston. As a matter of fact, a far greater number of pistons are broken in this way than there are due to defects in the pistons themselves. We especially urge upon users of our tools the importance of this matter of chisel shanks, and attention to it will obviate needless expense and annoyance.

In screwing the tools on the hose, screw them on tight enough so that there is no looseness of the nipple in the head of the tools, otherwise the jar and vibration of the tool in use will soon destroy the threads of the nipple and in the head. It is a very good practice to use a male and female nipple screwed tight in the head and left there, then the threads in the head are protected and the nipple is easily replaced when worn out.

One more point in the use of tools should be observed, and that is to see that when the workmen lay them down temporarily, they are not thrown indiscriminately into a pile of dirt, as stone dirt and grit finding entrance through the lower end can do just as much damage as if it came through the hose from an unscreened compressor suction.—*W. H. Van Sickle.*

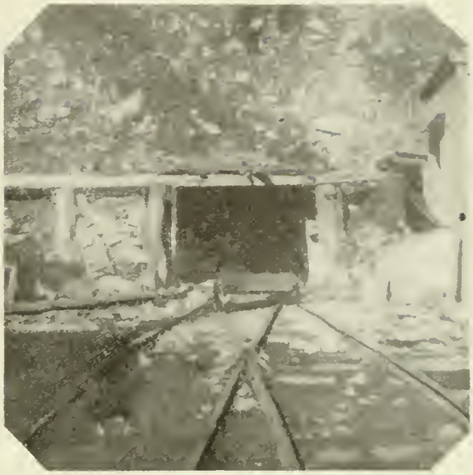


FIG. II.—OTIRA MOUTH OF TUNNEL.

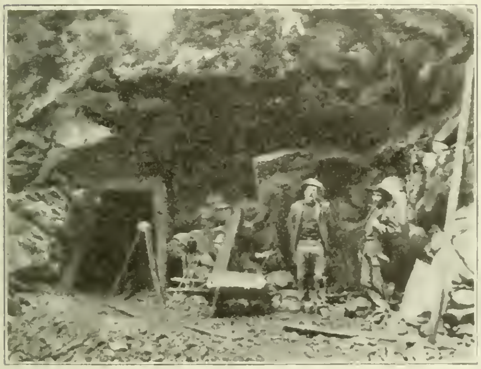


FIG. I.—TUNNEL FOR WATER POWER.

THE HOLE IN THE HILL—A NEW ZEALAND TUNNEL ENTERPRISE

We have received the first number of *The Hole in the Hill Magazine,* published at Otira, New Zealand. The hole in the hill from which the publication takes its name is the Arthur's Pass tunnel on the Midland Railway, now being driven from Otira to Bealey.

Although this work is about as far out of the way as well could be it is being carried on by the most advanced methods and with up-to-date facilities. The contractors before commencing operations made a study of the Loetchberg tunnel work, which doubtless largely determined the selection of equipments Within workable distance from the tunnel at each end water powers are available, so that electric transmission is employed, the plant at the tunnel comprising four Ingersoll Rand compressors, 24 Ingersoll-Rand 3 1-4 inch drills and several hammer drills. The accompanying half-tones are reproduced from the *Hole in the Hill Magazine.* Fig. 1 shows a small, short tunnel through which a wooden pipe was laid for driving the generators. Fig. 2 is the Otira mouth of the main tunnel and Fig. 3 shows a bit of Tunnel Town where the men live. We hope to give fuller particulars of this work later.

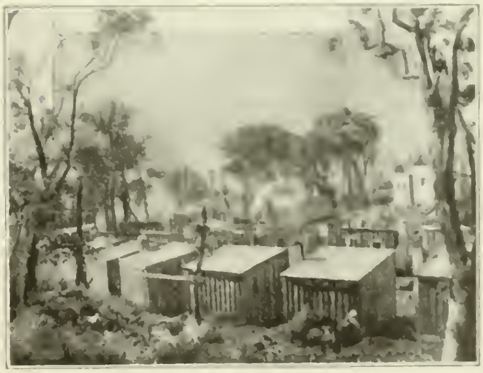


FIG. III.—BIT OF TUNNEL TOWN.

TRICKS WITH SOAP BUBBLES.

By Percy Collins.

[If the blowing of soap bubbles is not a compressed air operation we do not know what is, and our reproduction of the following highly interesting article from the pages of the *Scientific American* is justified both by its topic and by its exceptional intrinsic value to those who are interested in such lines of curious and ingenious experiment. Ed. C. A.]

Probably most people are of the opinion that bubble blowing is a purely childish pastime. But this is a mistake. Soap bubbles may be conveniently employed to demonstrate certain physical laws. Take, for example, the matter of surface tension. If we blow a bubble upon the bowl of a clay pipe, and remove the stem of the pipe from our mouth, the bubble slowly collapses. This is because the curved outer and inner layers of thin film, being at a tension, press upon the interior air and drive it back through the stem of the pipe. Again, if we blow two bubbles from two pipes, and connect the stems of the latter by means of a rubber tube, the smaller of the two bubbles will collapse, while the larger will increase in size. The explanation of this is that the bubble of smaller radius has its surface layers more sharply curved, and therefore exerts a greater pressure on the air within than does the larger bubble.

The writer, however, proposes to deal with soap bubbles mainly as a means of entertainment, leaving the reader (if he be so minded) to work out for himself their scientific possibilities. It may be said at once that upon the solution used success in bubble blowing entirely depends. The least elaborate formula, good yellow soap properly combined with pure water, is probably the best. Much depends, however, upon the manner of mixing. Take a bowl of slightly warm water, and rub in it a piece of good soap until a strong lather is formed. Skim off every particle of the lather with a spoon, and proceed to test the solution. First blow a bubble about six inches in diameter from the bowl of a pipe. Then dip your finger into the coap solution, and attempt to thrust the former into the center of the bubble. If it does not collapse, the solution is ready for use. If it bursts in the ordeal, more soap must be added until satisfactory.

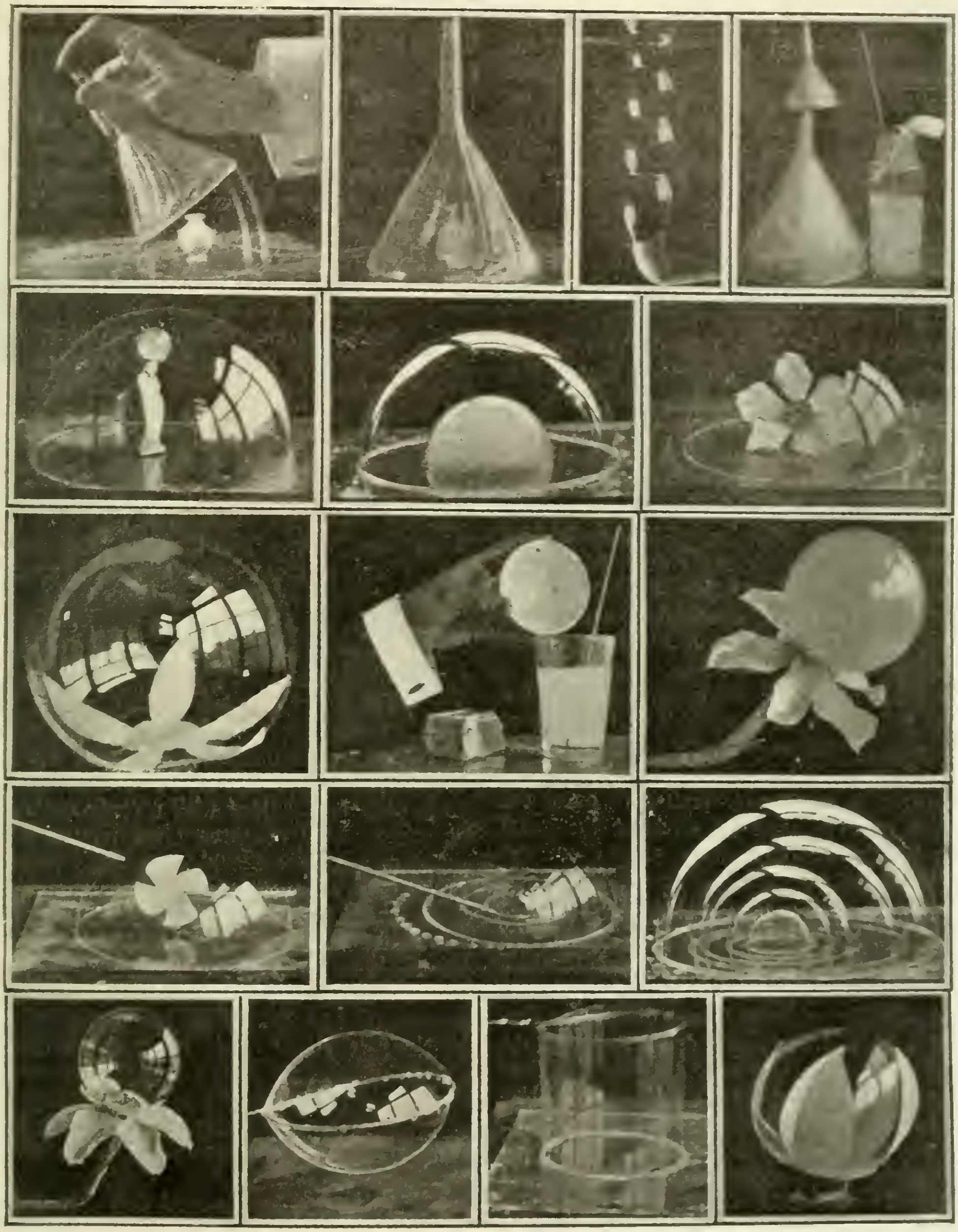
When once made, never disturb it. Many may think that occasional stirring will render it more uniform in strength, and better, but this is a great mistake; and the amateur will soon find that any disturbance of his solution will render tricks impossible that are otherwise quite easy to perform.

For artistic blowing, a little apparatus will be necessary. A straw or two, a clay pipe, one or two funnels of different sizes, and a ring made by twisting a wire round a bottle will be needed. Moisten thoroughly with the solution every article just before it is brought into use; and for this reason it is a good plan to keep one's straws standing in a half-filled jar or tumbler of soap solution.

For a pretty trick, attempt to form a string of bubbles—blowing one with the pipe, throwing it into the air, blowing a second, catching the first upon it, and so on until the chain collapses. With practice, a chain of five or six, or even more, bubbles may be formed. The trick has the advantage of demonstrating the quality of the solution if this be in question, and it is therefore a good one to commence with. Chain making is by no means as simple as certain other tricks which, at first sight, appear far more elaborate. For instance, it is quite an easy matter to blow a number of bubbles one inside the other. First pour a thin film of solution upon a sheet of glass, then dip your straw and blow upon the glass a good sized hemispherical bubble. Now dip the straw again, thrust it boldly through the side of the big bubble, and proceed to blow a somewhat smaller bubble inside. Repeat the process as often as possible, and a very pretty series of iridescent hemispheres will be the result. An accomplished bubble blower will sometimes form a dozen before the inevitable dissolution ends his triumph. Much depends upon the steadiness of hand and eye.

A variation of this trick takes the form of a "poached egg." First, a large bubble is blown upon the sheet of glass in the ordinary way; then a "pull" is taken at one's pipe or cigarette, the while the straw is redipped, and the second bubble within the first is inflated with smoke instead of air. The result is a beautiful white, solid-looking hemisphere within another shining with rainbow colors.

A good deal of fun at a bubble party may be secured by asking a novice to place a bubble upon a flower. He will make attempts, but



SOAP BUBBLE TRICKS.

without success. Then the master of the ceremonies will do it with ease, as his flower is first secretly smeared with soap solution, which provides, so to speak, a "foothold" for the bubble. Both smoke-filled and clear bubbles may be used effectively; and a number of flowers of different kinds may be adorned. If the solution be strong and good, it is quite easy to make a dozen or more "bubble flowers" before the first one bursts.

The wire ring may now be brought into play with somewhat astonishing results. An ordinary hemispherical bubble may be blown upon the sheet of glass, and then drawn up with the ring to form a cylinder. Of Course, the ring must be first dipped in solution, when it will be found to adhere tenaciously to the outer surface of the bubble.

By blowing a bubble with the pipe, throwing it into the air, and then catching it with two rings of soaped wire, the bubble may be pulled into a barrel shape.

An elliptical bubble is made by first dipping a wire ring into the solution, so that a film stretches across the opening; then, with a straw, blowing a bubble upon this film. Two bubbles are actually formed in close contact, the result resembling an old-fashioned lens, as shown in the half tone.

Another very effective trick may be described as the opening and closing flower. A five-pointed corolla should be cut out of rather thin white paper, mounted with a pin point upon the cork of a small bottle, and well smeared with soap solution. Upon this a good-sized bubble is to be mounted. If the bubble does not of itself pick of the rays of the corolla, they may be quite easily adjusted as pictured. When these preparations are complete, it is an easy matter to make the flower open or close by thrusting the straw into the bubble, and either sucking out air, or blowing it in.

We may wish to blow a bubble over a flower or any other object. Begin by placing the flower upon the sheet of soapy glass, or in a shallow saucer containing a little solution. Over the flower put a funnel of suitable size, and start to blow gently down the tube, the while you cautiously raise the funnel. Continue to blow until a sufficiently large bubble is formed. Then disengage it from the funnel by turning the latter carefully at right angles, the finger being applied to the opening of the tube. To accomplish this feat (shown in the illustration) calls for a little practice; but the novice will generally succeed after three or four attempts.

One may vary it by blowing a bubble over a small statuette or ornament, previously preparing the same by fixing a tiny circle of paper well damped with soap solution upon its summit by means of an atom of cobbler's wax. Then, upon this platform, a little smoke-filled bubble may be blown, as shown in the photograph.

A bubble may be blown over a little pinwheel, made from paper, a small cork being used as a support. The wheel may be set in rapid motion within the bubble by a current of air blown through the ever-useful straw, the bubble increasing in size as long as the wheel is kept spinning.

The foregoing hints by no means exhaust the possibilities of the art.

But pipes, funnels, straws—everything, in fine, that a bubble is to be blown from, or is to touch—must be thoroughly anointed. For if one tries to blow a bubble from a dry pipe or funnel, or to transfer a bubble when blown to a dry surface, that bubble will certainly burst. This fact need not be divulged at the outset to onlookers. Indeed, a vast deal of fun may be derived from the failures of novices to imitate the tricks which the accomplished blower performs with much ease.

Bubble parties have proved a great success. Their nature should be indicated upon the cards of invitation, and preparations made before the hour of meeting. A large table is necessary; and should it have a polished surface likely to be damaged by the soapy water, a mackintosh sheet should be spread. Each guest must be provided with a chair and the materials. Two or three-glass funnels are sufficient and these should be carefully tested, as the rim of each must be quite true. A glass funnel enables one to get the object in the center over which the bubble is to be blown.

Pretty bowls and saucers, and dainty little ornaments, add greatly to the beauty of a bubble "set piece," such as some of those shown herewith. A bubble may just as readily be blown in a dainty saucer or other piece of china, by means of a funnel, as upon a flat sheet of glass, while the result will be infinitely superior.

[It is of course understood that soap bubbles and their accompaniments are not the best subjects in the world for the photographer, and the pictures grouped in the halftone may be considered remarkable triumphs of the art in themselves. Ed. C. A.]

The titles are as follows:

Top row: Raising funnel to complete bubble over object. Blowing bubble over object by aid of funnel. Blowing a chain of bubbles. Apparatus for blowing bubbles.

Second row: Small statuette inside a hemisphere. Smoke-inflated hemisphere inside rainbow colored one. Flower shown after disengagement from funnel.

Third row: Bubble mounted on rays of flower. Straw kept in solution ready for bubble blowing. Smoke bubble adorning a flower.

Fourth row: Hemisphere blown over pinwheel. Large bubble pierced for blowing a series of smaller ones. Many hemispheres may be formed before dissolution.

Fifth row: Bubble adorning flower; a dozen may be added. An elliptical bubble made by aid of wire ring. Hemisphere drawn up with a ring to form cylinder. Rays of flower closing in the bubble.

PNEUMATIC BRIDGE CAISSONS IN GREAT BRITAIN

In a recent paper before the Institution of Engineers and Shipbuilders in Scotland, Mr. Andrew S. Biggart described the operations in construction of a number of large bridges in Great Britain, in each of which undertakings the pneumatic caisson was a prominent feature, the work all executed by the firm of Sir William Arrol & Company (Limited) Glasgow.

The Clyde Bridge of the Caledonian Railway Company has five deck spans from 60 to 200 ft. long, carrying at one end nine tracks and at the other end thirteen tracks. Each of the river piers has five cylindrical columns seated on brick piers with rectangular pneumatic caisson foundations. The caissons are of steel and each of them had three 3½-ft. air shafts and was built on a falsework extending across the river, which also provided for the delivery and storage of materials and for the subsequent erection of the superstructure. Two wooden trestle bents were erected on the falsework on opposite sides of each caisson and each pair supported a pair of horizontal riveted steel plate girders forming gallows frames over the caissons. Four vertical rods, one near each corner of the caisson, were connected to the caisson and, passing between the pairs of girders, engaged saddles commanded by hydraulic jacks. The caisson was lowered by the jacks to water level, concreted and again lowered and released from the suspending rods and concreted until it took bearing on the river bed. During this operation the caisson was maintained in horizontal position by guys, but rose and fell with the tide.

The bridge over the River Barrow in the south of Ireland has thirteen 140-ft. fixed spans and one 215-ft. swing span with 15 piers, each made with two 8-ft. cylinders 26 ft. apart on centers which had their bases extended to a diameter of from 10 to 15 ft. The lower portions of the cylinders were made with steel rings up to about the bottom of the river, and above that the cylinders were made with cast-iron rings. The cylinders were assembled on lateral extensions of a wooden falsework platform built across the river, the working chamber and the adjacent cylinder rings were lined with concrete and lowered to the river bottom by hydraulic jacks. The excavation in them was partly made by grabs, but in every case was finished under pneumatic pressure. The upper rings were added and concreting between the air shaft and the rings was continued as the cylinders sank. Although they were carried down to an extreme depth of 120 ft. below high water level, the pressure was reduced by special measures to a maximum of 45 lb. per square inch. This was mainly accomplished by the use of ejectors operated by compressed air to remove the water which came in under the cutting edge. The usual precautions were taken for the safety of the workmen by reducing the hours of work, restricting the speed of their exit, and providing warm refreshments and rest for them immediately after emerging from pressure. After the working chamber was concreted the air pressure was maintained on it for several days. The top ring of the cylinder was made of special depth to bring the upper edge to the required level. The cost of excavation at the maximum depth reached $200 per cubic yard.

The Suir Bridge, near the Barrow Bridge, carries the same single track railway on nine spans of about 140 ft., with cylinder piers similar to those of the Barrow Bridge, but not sunk to so great a depth. When one of the cylinders had been sunk to a depth of 70 ft. below the river bottom and subjected to a pressure of 32 lb., one of the cast iron rings, just below the bed of the river, burst, under a tensile stress of about 1,000 lb. per square inch. The casting had been satisfactorily tested before acceptance and pieces of it were tested after the accident and gave results up to the specifications without disclosing any flaw in the metal. No explanation has been offered for the break. A wooden cofferdam was built around the top of the cylinder and pumped out, and the broken ring was removed and replaced by a new one and a concentric steel shaft 3 ft. in diameter was set in it and extended down through the concrete lining to a point 5 ft. below the upper end of the steel portion of the cylinder. The lower 9 ft. of this shaft was then grouted to the concrete filling, the air lock was placed on top of it, and sinking successfully completed.

The Black Friars Bridge over the Thames, in London, has five flat steel arch spans of 155 to 185 ft., which were recently enlarged by extending the width of the structure from 43 to 73ft. This involved a corresponding extension of 30 ft. at one end of all the piers, which were of masonry and were each supported on several rectangular pneumatic caissons and one triangular caisson forming a cut-water at the upstream end, where the extension was made. Pile falsework platforms were made enclosing the upstream ends of the piers and extending 10 ft. beyond the pier on each side and 60 or 70 ft. beyond it upstream. Steel pneumatic caissons for the foundations of the pier extensions with a semi-circular cut-water on the upstream end and a recess on the downstream end to fit the nose of the old cut-water, were assembled and riveted on the falsework. The downstream end of the caisson did not, however, reach entirely to the main part of the old pier, but left a narrow gap there on each side of the downstream end of the old cut-water. The caissons were assembled by steel stiffleg derricks installed on the falsework platforms. A timber trestle was built parallel to the axis of the caisson on each side of it on the deck of the falsework platforms and two pairs of steel plate girders were seated on them, one at each end of the caisson, provided with vertical rods and hydraulic jacks by which the caisson was slightly lifted while the supports under it were removed. Concrete was filled into the cutting edge and on the roof of the caisson and it was lowered to the bottom of the river, the sides being carried up by a temporary steel cofferdam continuous with them and heavily braced with interior timbers as it descended. The caissons were sunk just below the bottom of the river and the side spaces between the old and new caissons were enclosed by wooden cofferdams which were pumped out, allowing them to be excavated and concreted.

After one of the caissons had been lowered a few feet below high water and was still suspended from the overhead girders, the hydraulic jack which supported one of its corners was prematurely exhausted, relieving the opposite diagonal jack of its load, throwing the entire 250-ton weight of the caisson on the remaining two jacks and settling the piles under one of them a few inches. This movement caused the caisson to swing and the falsework to collapse, precipitating the caisson to the bottom of the river. The caisson was then braced by interior cross girders and web plate brackets and the point was lifted by hydraulic jacks operating bars suspended from two box girders braced together on the falsework platform. The caisson was then moved to proper position on sliding bearings and was sunk in the usual manner.

TWO ELECTRIC-AIR DRILL RECORDS, WITH COSTS

The Brier Hill Collieries of Crawford, Tenn., have been using one of these drills, a 5 D, in their mines for about 18 months for drilling holes in the roofs of several entries. The rock varies from slate to sandstone and conglomerate rock, and Mr. E. B. Taylor, general manager of the mines, who has kindly furnished us with the information regarding this drill, states that the drilling was done through the hardest roof he had ever encountered in 30 years' mining experience.

A 5 D drill is equivalent to an Ingersoll-Sergeant 3½-in. air drill, and has a stroke of a little more than 8 in. It will drill a 16- ft. vertical hole from 1¾ to 2¾ in. in diameter. It has a 5½-HP. motor. Such a drill is intended for the heaviest work in large tunnel headings, open cut work in quarries or railroad grading, or in shaft sinking, or mining.

During 16 months' work with this drill, holes were drilled in the roof of the main entry of one mine, a distance of 600 lin. ft., in driving three entries of another mine, a distance of 250 ft. in a new haulway, 200 ft. in the 2d left entry, and 275 ft. in the 3d left entry.

These three entries were driven simultaneously, the drill being moved from one entry to another as it was needed. Only one hole was drilled in the roof of each of these entries each day, the average depth of a hole being 7 ft. It took the drill runner and a helper from 20 to 30 mins. to unload the drill from a car and set it up, while the hole was drilled in about 20 mins. About a half day was consumed in drilling the three holes and making the necessary moves, more than three-quarters of the time being taken up in moving and setting up the drill.

With wages for the drill runner at $3.50 for a 9-hour day and $2 for the helper, this gives a labor cost of 13 cts. per lin. ft. of drilling. Upon one occasion the crew drilled 7 holes in a 9-hour shift, aggregating 42 ft. 6 ins., which substantiates the cost of 13 cts. per lin. ft. Mr. Taylor states that during the 16 months this work was going on, outside of sharpening the steel bits, not one cent was spent in repairs or for maintaining the drill—a rather unusual record for any drill.

The Superior Portland Cement Co., of Superior, Ohio, have three 5 C size of these drills at work in their limestone quarries. We are indebted to Mr. J. B. John, manager of the company, for the following account of work done by these drills.

The vein of limestone averages about 8 ft. in thickness. To blast out this limestone, holes 6 ft. deep and 2½ in. in diameter are drilled. Each drill puts down, on an average, 17 of these holes per day. Thus three drills do 306 lin. ft. of drilling per day. There is blasted out an average of 500 tons of limestone per day, equivalent to 220 cu. yds. This gives an average of 1.4 lin. ft. of drilling per cubic yard of rock blasted, place measurement.

With wages for the drill runner at $3.50 per day, and helper at $2 per day, this gives a cost for labor for drilling of 5.4 cts. per lin. ft., and 7.5 cts. per cu. yd. of rock blasted, which is a very low cost, accounted for, however, by the rapid drilling done by this machine.

Another factor that enters into the rapid work done by one of these drills is its tremendous back-pull or stroke, making the drill work itself loose in a bad hole and preventing it becoming "stuck." Even when the steel binds, there is a pull and push on the piston, at full power, for every revolution of the pulsator; and this works it loose almost instantly. Mr. John states that the wear and tear on these drills has been very light.

The method of moving the pulsator and dynamo in the quarry was very simple. These two are mounted on a common bed which has two sets of wheels under it. A cheap wooden frame for a track was made in sections, for the truck to run on. Only a few of these sections were needed and they were light, inexpensive and easily handled. Small steel rails can also be made up in sections and used in the same manner, and naturally they will give better service, as well as allow of a better joint being made between the sections. When a good hard bottom occurs in the mine or quarry, the pulsator and motor can be moved from place to place without any track, the wheels running directly on the rock. On tracks it can be carried over rough ground or muck piles with the aid of blocks and tackle.—*Engineering-Contracting.*

ELECTRIC MOTORS FOR COMPESSORS

By W. L. Wotherspoon.

The electrical air compressor is the result of an extended study of conditions on the part of both pneumatic and electrical engineers, and has shown itself peculiarly adapted for its work wherever electric power is available at a rate which makes its use commercially attractive. The process at the very root of mine production is the breaking of the rock, and thus far electricity has not been found equal to the demands of this situation. So long as the air drill holds its sway, compressors must be run, and the application of electrical power to the compression of air is an interesting problem which has taxed the skill of pneumatic and electrical engineer alike. The unit is composed of three distinct elements—the motor, the compressor and the method of drive—but in these notes the motor will be considered. The type of motor will be usually determined by the character of the current available. If it be from a direct current source, a slow or moderate speed direct current motor will be used. Such a motor may be operated at variable speed by means of some of the many methods of speed control, but this is a contingency which need not be considered in the average mining plant. For while the mine load is a variable one, speed variation cannot be economically secured in a motor by electrical means, and fluctuations of load can be much more efficiently cared for by some of the standard motors which operate at a constant speed, assisted by regulators, than by a variation of piston speed and displacements. It may also be stated as a rule of practice that a variable-speed motor for driving a compressor has no place in the mine plant. When circumstances settle the use of an alternating current motor, the choice is usually between the synchronous and the induction types. The former has certain virtues and defects. In the first place, it is not self-starting, and requires some separate source of power—probably a small induction motor—to bring it up to full speed before any local can be thrown upon it. The synchronous motor requires, moreover, a source of direct current to excite its field. Once up to normal speed, this type of motor is essentially a constant-speed machine, and within its limit of power capacity will maintain its speed regardless of fluctuating load. Should a sudden overload occur the synchronous motor drops out of step and stops. Some assert this an advantage acting in the nature of an auxilliary relief to prevent explosions or burnouts. It is also claimed for the synchronous motor that its power factor is unity, but this is true only when the motor field is correctly adjusted to the motor load, and any variation of that load will cause the current to lag or lead, as may be, and the power factor becomes a variable quantity. Where it is possible to vary the motor field automatically with the varying load, the power factor might maintain at unity, and this disturbing effect of the synchronous motor would be omitted.—*Journal of the Transvaal Institute of Mechanical Engineers.*

AIR RECEIVERS

The uses of compressed air are so varied that no definite rules can be laid down to cover all requirements of the receiver. That a receiver is desirable seems to be generally conceded, but the reasons for its use seem to be rather confused.

The most important functions of a receiver can be divided under four heads: To act as a temporary reservoir; to collect the water and grease and insure dry air; to reduce the loss caused by friction in the pipes, and to equalize the pulsations and steady the flow of air to the place of use.

The first function of a receiver that occurs to most people is that it will act as a reservoir of power. This is true, to a certain extent, if the receiver is made large enough, but in most cases this would require a receiver so large as to be prohibitory. For this reason the plan of using the receiver as a reservoir will never be satisfactory, and the extra money spent for the reservoir would be better used if expended in the purchase of a compressor of sufficient capacity to supply the greatest demand put upon it.

An idea of the size of receiver necessary to act as a reservoir can be had from the following example of a 24x30 compressor, running at 85 revolutions per minute at a working pressure of 110 pounds. It would require a receiver 5 feet in diameter and 60 feet long to keep up the work of the compressor one minute after it had been stopped and not allow the pressure to drop more than 15 pounds, while if the compressor was at work and the demand for air was 25 per cent. greater than the capacity of the compressor in four minutes it would lower the pressure 15 pounds. The real value of the receiver is when the demand for air is very irregular, the advantage being due to the fact that the compressor stores energy in the receiver without any great change in pressure when the demand for air is less. This saves the compressor from the hard usage caused by a varying change in the load, and avoids the loss caused by free expansion, which would result if no receiver were used. When the variation in the quantity of air used is very great, and a uniform pressure is required, an unloader is often used.

The receiver when properly connected serves as a means for removing the water and grease from the air. The inlet to the receiver should be at the bottom, and the outlet at the top. This applies to both the vertical and horizontal types. See Figs. 1 and 2. To each receiver should be fitted a pressure gage, safety valve and drain. The water and grease are drained from the air by allowing it to pause in its flow, to cool and to drop the water and grease which would otherwise be carried along by the current of air. If the receiver is too close to the compressor the air will not have time to cool sufficiently. The general practice is to place the receiver about 50 feet from the compressor. If the air is not sufficiently dry to prevent freezing after having passed through the receiver, it may be farther dried by placing a separator in the pipe line, made as shown in Fig. 3. The shell is made from a 6, 8 or 10-inch nipple, according to the size of air line, with caps screwed over the ends. The bottom cap is drilled and tapped for the drain, and the top cap for the inlet and outlet pipes. This separator should be placed at the end of the air line, and at the lowest point in the pipe system.

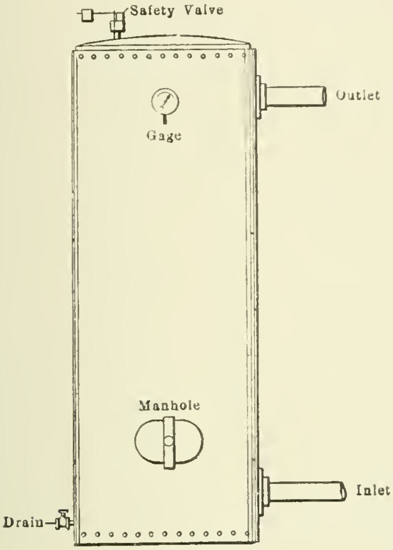


FIG. I. VERTICAL RECEIVER

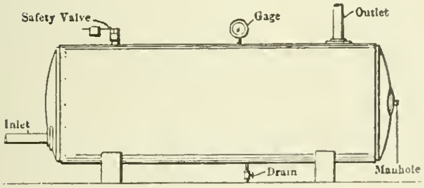


FIG. 2. HORIZONTAL RECEIVER

The air may also be dried by placing a second receiver at the end of the air line. This also is useful in reducing the loss by friction of the air in the pipe system. When air is quickly withdrawn from the pipe the pressure will momentarily drop below the average. If a receiver is placed as near the scene of action as possible this loss of pressure and the momentary fluctuations will, to a large extent, be prevented. Also, by keeping a uniform pressure at each end of the air line, the flow of air will be more uniform, and the pipe friction will then become a constant quantity, due to the average consumption of air and the difference in pressure of the two receivers at the ends of the pipe. Since the friction loss varies as the square of the velocity, it is readily seen that the loss is least when the velocity is that due to the average air consumption.

The fourth function, the equalizing of the pulsations and steadying the flow of air to the place of use, is similar in principle to the third function. As the air comes from the compressor into the pipe, the pressure will run up momentarily far in excess of the average pressure used, unless there is sufficient space for its immediate accommodation. This will throw unnecessary strain on the compressor, and also consume power. By placing a receiver in the air line this difficulty is relieved and a steady flow of air is sent into the pipe leading to the work.

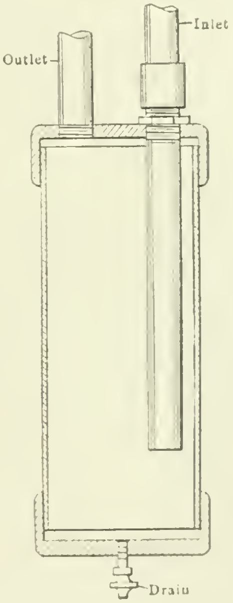


FIG. 3.—SEPARATOR.

The size of receiver required depends upon the rapidity with which the air is drawn from it, and the drop in pressure which is permissible. The size also depends upon the working pressure, and in general it can be said that the greater the working pressure, the smaller the size of receiver that can be used for a given number of cubic feet of free air per minute. Fig. 4 is a diagram showing the general practice in selecting the size of receiver under ordinary conditions. For example, to find the size of receiver necessary for an 1100 cubic-foot machine at 110 pounds working pressure, project across to the 110-pound curve, and then down to the lower margin, where the size is found to be 140 cubic feet. From this the dimensions of the receiver can be computed.

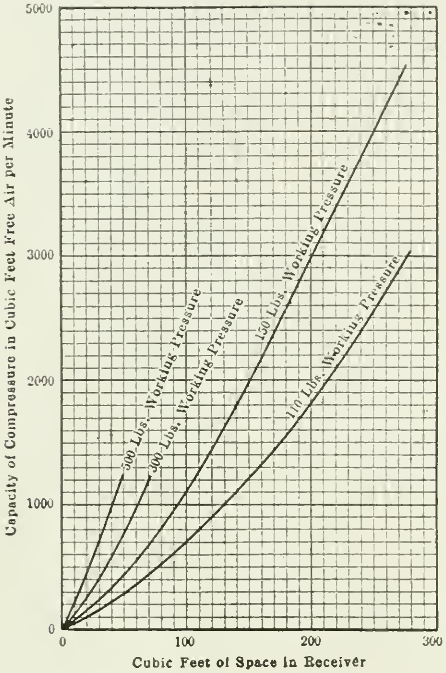


FIG. 4. CAPACITY OF AIR RECEIVERS

Receivers should be made of the best 60,000-tensile-strength steel. The side seams should be double-riveted, and strongly made with dished heads, and tested at a pressure 50 per cent. greater than the maximum pressure used. The larger sizes should be provided with manholes. To prevent too great an accumulation of water and grease, the drains of the receiver should be opened frequently.—*John B. Sperry* in *Power and the Engineer.*

[It will frequently or generally happen that little or no water will be drawn from a receiver placed near the compressor, while if the line is of sufficient length for the air to become thoroughly cooled and another receiver is placed at that distance, the air being still, water will be deposited requiring frequent drawing off and then leaving the air so dry that there is no trouble from water or from freezing up when the air is used. Ed. C. A.]

AN AIR EXCLUDING FIRE EXTINGUISHING COMPOUND

German fire departments have been investigating means and methods for extinguishing burning gasoline, benzine and other liquid hydrocarbons, the use of water for the purpose being so unsuccessful, and in consequence a novel compound has been brought out the use of which shows remarkable results. Two separate aqueous solutions are prepared, one of potash, alum and sodium sulphate, and the other of sodium bicarbide, sodium sulphate and licorice-root extract. These are contained in two chambers of a small metal cylinder with a long spout and so arranged that on being inclined or reversed the two solutions mingle as they flow. There is no pressure except that due to gravity, and consequently the liquid does not issue with sufficient force to cause a spattering of the burning hydrocarbon upon which it may be poured. The result of the chemical reaction between the alum and the bicarbonate is an immediate evolution of carbon dioxide which, in contact with the licorice solution, forms an exceedingly stiff and persistent foam. Such a layer of foam, containing an inert gas, upon the surface of a burning liquid effectually cuts off all access of air, and combustion necessarily ceases. The temperature of the liquid may have reached a sufficiently high point so that through evaporation bubbles of the vaporized hydrocarbon rise for a time through the stratum of foam, and tongues of flame play over its surface. These soon cease, however, for simultaneously with the evaporation of the carbon dioxide there is a loss of latent heat, the temperature of the foam-yielding solution falls, and this in turn cools down the combustible liquid. The foam extinguisher is believed to be specially applicable to automobile garages, motor yachts and places where combustible liquids are stored or handled for sale or otherwise.

A SUCCESSFUL AIR LIFT INSTALLATION.

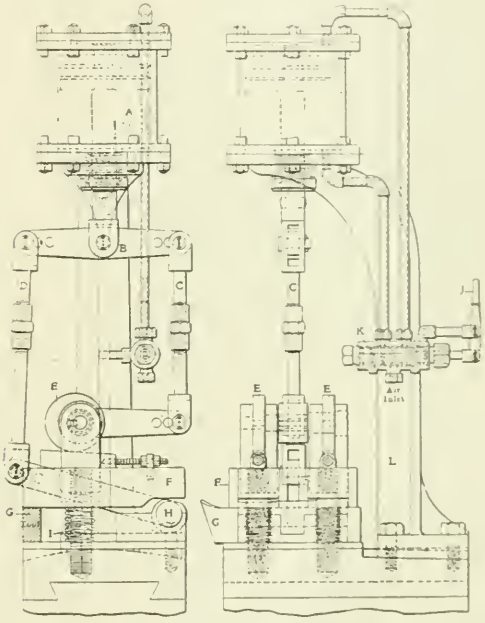
The city of Ottawa, Ill., depends upon flowing wells for its water supply; the increase of consumption has made the supply inadequate and lately the air lift has been installed with highly gratifying results. An Ingersoll-Rand Class A compressor 14 and 14¼x14 was placed in position and piped to four wells. These wells were 6 inch with a maximum aggregate flow of about 90 gallons per minute or, say, 500,000 gallons per day. The air pipe used in the wells was 2 in. carried down 100 feet, and when the air was turned on the tests showed a delivery of 2,500,000 gallons per day, while only 1,500,000 gallons had been guaranteed. The water supply is now much in excess of present requirements, so that the air lifts will not be operated continuously.

A PNEUMATIC TOOL FASTENER

The new so-called high speed steels for metal cutting tools have found nowhere a better opportunity for the display of their time saving qualities than in the turning of the tires of locomotive driving wheels in railroad shops. This is a job of constant occurrence and the speed at which it is now accomplished is continually astonishing the old timers of the shops. The rivalry of the different shops and the continued effort to make new records in this special operation have caused attention to be paid to all the details of manipulation with a view to the saving of time in all directions. The development and use of one of these time and labor savers is thus described by the designer of it, Mr. W. A. Anthony, Elizabeth, N. J., in the *American Machinist*.

Some time ago there there were installed in the Philadelphia & Reading Railroad Company's wheel shops at Reading, Penn., two 40-inch and two 90-inch tire lathes that were built by the Niles-Bement-Pond Company. As competition in turning out work is very keen, it seemed to me there was room for improvement. While observing the differences in the amount of work turned out, I started the designing and building of the automatic tool holder described below, and now, with its help, one man, on one machine, is turning out more work in one day than in any other place in the world.

With an operator well broken in, we found it possible to turn out 10 pairs of 36-inch wheels in 10 hours, by using these machines as they were received from the builders. By placing a tool bench back of the operator so that he would not have to move to place his hand on any tool he desired; by putting on his tool rests a pair of removable two-way ratchets that could make a complete revolution, thus making adjustment of his tools an easy matter, and by making a pair of adjustable skids that could be used for any size axle, in putting in, and taking out, the wheels, we increased the output to 12 pairs of 36-inch wheels in 10 hours.



PNEUMATIC TOOL FASTENER.

The operator then claimed that his only drawback, in turning out more work was the time and labor lost in putting in and taking out the tools. As five pairs of tools are used in turning one pair of wheels, not counting the tools krocked out by striking hard spots, you will see that the adjustment of tools consumed considerable time and hard labor during a day's work. Each tool clamp has four 1½ inch nuts to tighten with a 40-inch wrench, thus making a total of 80 nuts to screw and unscrew in the turning of one pair of wheels.

With this automatic tool holder the time and labor has been reduced to a minimum, and one machine to-day is averaging 16 pairs of 36-inch wheels every 10 hours.

The design of this pneumatic tool holder is shown in the line cut. The air cylinder *A* is used with 90 pounds of air and pulls up the equalizing lever *B* and with it the eccentric rod *C* thus causing the cams *E*, with a 7-16-inch throw, to push down the tool clamps *F* against the tool *G* and hold them there. The difference in the throws of cams *E* and *H* allows a margin for placing and removing the tools and also causes the eccentric rod *D* to pull up the cams *H*, with a 3-16-inch throw, and thus push up clamps *F* in the rear and down in the front. This acts as a wedge and pinch bar, making the tool unmovable with one movement of the hand on the air-lever *J*. The springs *I* lift up the clamps F when the air is released, allowing the removal of the tool with ease. The valve *K* is a four-way air valve that is used both ways. The housing *L* is cast steel and fastened to the tool rest with six 7-8-inch studs.

EFFECTIVE DISCIPLINE

There are now ten apprentice schools on the New York Central Lines, with a total of 547 apprentices. Things are looked after in these schools as strictly as in any college. It is required of the boys, not to take too much of the shop time, that a considerable part of the problems which come up shall be done at home. The delinquent student in this college goes up before a faculty consisting of a division foreman.

"I find," said this Nemesis to a boy in the West Albany shop a little while ago, "that you haven't been working out the problems given to you, and that you're away behind."

"Yes, sir; I guess that's right."

"Well, you've got just one more chance. Work 'em or go get your time."

At shop time next morning the backslider walked up with a handful of problem papers, and all were solved.

"All these?" said the faculty, in surprise, "when did you do 'em?"

"Last night."

"H'm! It must have taken some time."

"It took all night. I haven't been to bed."

And having "worked off his condition," he went back to his job in the shops and put in a full day, and we may be sure that experience was not repeated.

HIGH PRESSURE GAS TRANSMISSION

During the past few years the apparatus for manufacturing and purifying gas has been greatly improved, and the many by-products obtained have found wide demand. To economically prepare these by-products in marketable shape requires a plant of comparatively large production, so that the tendency now is to centralize the point of manufacture for several neighboring communities, thus obtaining the benefits resulting from the disposal of the by-products.

This idea of a central plant supplying a considerable area, naturally implies the necessity of many miles of piping, which, applied to the ordinary low-pressure system with its large, heavy pipes, means a large outlay of capital. With the high-pressure system of gas transmission, these disadvantages are avoided and many additional advantages are obtained.

The installation of a compressor to accomplish this stepping up of the pressure from that at which the gas is produced to that at which it is transmitted, involves no complication of apparatus and no considerable outlay of capital. A large compressor is seldom necessary; and, with a suitable governing device, no special attention is required to insure perfectly reliable operation.

The standard types of air compressors used in steam and electric railroad service, and manufactured by the Westinghouse Air Brake Company, are well adapted for compressing gas for transmission at high pressure. They may be driven either by steam or by electric motor. The two types of compressors are illustrated in the accompanying half-tones.

The compressor is so located and connected as to draw the low-pressure gas directly from the gasometer, compress it and deliver it through a suitable storage reservoir into the high pressure main. For cases where the high pressure is required to be constant during the twenty-four hours, an automatic governor may be applied to the compressor, which regulates its speed so as to maintain the desired pressure practically constant. For cases where the high-pressure is raised to a certain maximum and allowed to decrease to a fixed minimum, a governor may be furnished which will stop and start the compressor within this desired range of pressures.

The following application illustrates the simplicity of this system. An Eastern municipal gas and electric light plant supplies three neighboring towns. It is situated in the central part of one town and is from three to four miles from the others. The whole town where the plant is situated is supplied with low-pressure gas, flowing directly from the gasometer through large mains at a pressure of 2½ inches of water. The other towns are supplied through high-pressure mains, the gas being drawn from the gasometer by the compressor and delivered directly into the high-pressure mains. A governing valve is placed in each house supplied by these high-pressure mains, which automatically reduces the pressure to the low house service pressure. About fifteen miles of two inch-pipe are already laid in the territory of about four miles' radius covered by the high-pressure system.

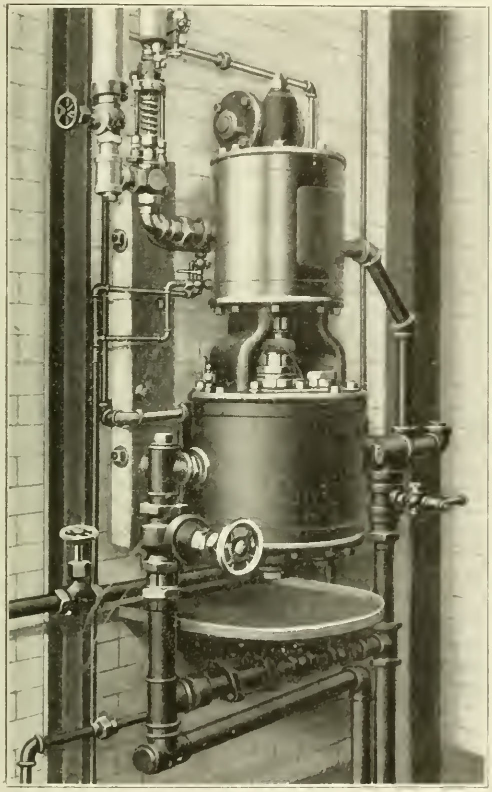


FIG. I.—STEAM DRIVEN GAS COMPRESSOR.

The gas compressing outfit in this plant consists of two 9½x13x10 inches water-jacketed compressors mounted on the wall of the engine room. The steam pressure varies from 60 to 100 pounds at different periods of the day. Only one compressor is used at a time. The low gas pressure is very constant. The high pressure varies from 10 to 14 pounds, being lowest in the day time when the steam pressure is low. The average number of cubic feet of gas delivered during the day time appears to be from 10 to 12 cubic feet per minute, running up to about 25 cubic feet in the late afternoon, at the time when gas is required for both lighting and cooking.

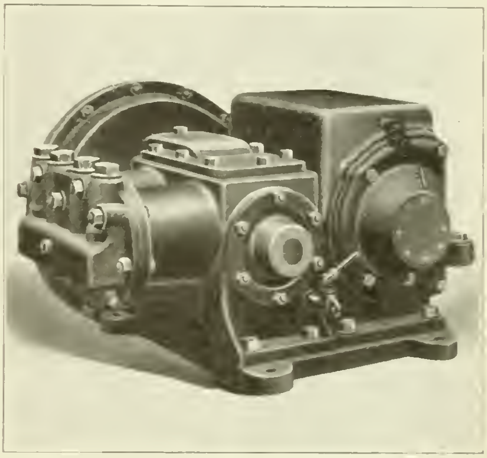


FIG. II.—ELECTRIC DRIVEN GAS COMPRESSOR

The management of the gas works expresses itself as perfectly satisfied with the compressor operation. The operating unit is shut down only occasionally, about once or twice a month, during the hours of the day when the gas consumption is lightest, to clean and oil the valves, and the storage in the mains is then enough to supply the demand until the plant can be started again. At all other times no attention whatever is paid to the compressor, outside of oiling.

The French mints are coming for the first time 25 and 10 centime pieces made of aluminum. The nominal value of the new issue will be about $12,000,000, while the actual cost will be not more than one-fifth of this. Nickel 25 centime pieces, worth nearly the same as our nickel, are in use and will not be withdrawn.

IDEAL MACHINE EFFICIENCY

With reference to machinery, there is no sound reason for considering that to put it to use implies the beginning of its deterioration; a machine, like an animal, properly proportioned to the work it is to do, should with proper control and maintenance increase in efficiency during certain of the first stages of its life. Therefore we must reach the conclusion that the real efficiency of an animal or of a machine is the average amount of work it has done as compared with what it was capable of doing, under intelligent control, during its life. An excessive output during a short period of that span is sure to result in a material reduction of the possible total. The life of a properly constructed and applied machine should be yielded up only to the inventor of its improved successor. It may be worth considering whether this was not the theory upon which the early civilized races of the East offered work animals as sacrifices on the altars of the gods.—Victor H. Becker in *Ice and Refrigeration.*

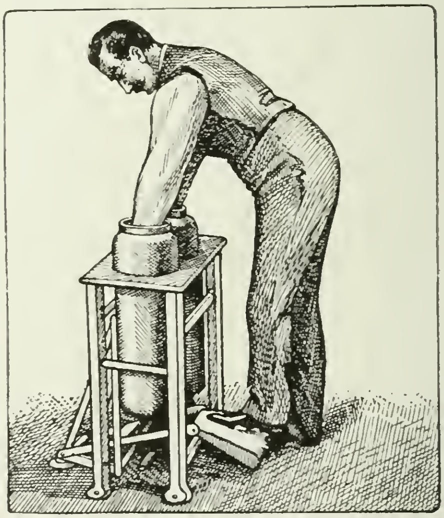
WHY IS THE SEA SALT

Sea water contains about 3½ per cent of sodium chloride and other salts. The evaporation of all the oceans would leave a mass of salt sufficient to cover the entire globe to the depth of 200 feet, and equal to the bulk, above sea level, of North and South America, or one-fourth that of the whole earth.

The theory that this enormous quantity of salt has been dissolved from continental rocks, and carried down to the sea by streams, is not tenable, because the salts found in solution in river water contain 80 per cent. of carbonate of lime and only 7 per cent. of chlorides, while common salt, or sodium chloride, constitutes 89 per cent. of the salts of sea water. Moreover, the evaporation of inland seas which has taken place in central Asia has left saline deposits very different in composition from the salts of the ocean.

It appears, therefore, that salinity must be regarded as an original property of the ocean. Suess has advanced the theory that the salts now found in the sea have been ejected by volcanoes in early stages of the earth's formation. Even now every eruption increases the quantity of water vapor, carbonic acid, and compounds of chlorine and sulphur in the atmosphere, and these substances ultimately find their way to the ocean. After every eruption of Vesuvius the crater is covered with a gleaming white layer of common salt, and the volcanoes of South America eject enormous quantities of hydrochloric acid—estimated as 30 tons daily for the volcano of Puracé, in Columbia.

This volcanic activity, now restricted to a few points of the earth's surface, must have been general in remote ages, before life appeared on the globe. The gases confined within the thin solid crust burst their bounds and found their way to the surface, bringing with them the millions of tons of chlorides which we find to-day in the oceans. Yet the transfer of these millions of tons is a relatively insignificant change, for on a terrestrial globe of a diameter equal to the average height of man (66½ inches), 1-16 inch would represent the greatest depth of the ocean, and the waters of the ocean contain only 3½ per cent. of solids.—*Cosmos.*



A RUBBER GLOVE DISTENDER

Skin-tight rubber gloves extending well up the arm are used by surgeons in certain dangerous operations, and the difficulty of getting them on can be imagined. The apparatus here shown makes the operation quick and simple. A glove is placed in each of the jars with an air tight fastening at the neck. The operating of the treadle makes a partial vacuum in the jars and outside the gloves, so distending them that the hands can be inserted with perfect ease.

INSECTS AS BEARERS OF DISEASE

Dr. L. O. Howard, chief of the Bureau of Entomology in a pamphlet recently issued by the Department of Agriculture, treats of insects as inimical to human health and comfort. He declares that the development of the whole state of New Jersey has been seriously retarded by mosquitoes in sections which are admirably adapted to dairy farming in other respects, but where this business had to be given up owing to the evil effect of the mosquitoes on the cattle. Many rich lands of the South cannot be developed as they would be, he says, because of the presence of the mosquito.

Dr. Howard declares that typhoid fever is not a national scourge, as it has been called, but rather a "national reproach," or a national crime, for its main source, the fly evil, can be controlled.

Dr. Howard says that many diseases are transmitted by insects. Yellow fever is carried by one brand of mosquito and malaria by another. The common house fly is an active agent in the dissemination of typhoid fever, Asiatic cholera and kindred intestinal disorders. The tropical disease known as filiariasis is transmitted by a species of mosquito. Bubonic plague is carried by fleas. The so-called spotted fever of the northern Rocky mountains is transmitted by a species of tick, just as Texas fever is given to cattle by the southern cattle tick.

He says that all the loss and suffering caused by these diseases are unnecessary as the diseases can be controlled by stamping out the insects that carry them.

THE GEOLOGIST IN LOUISIANA

A few years ago when an appropriation was asked for a geological survey of Louisiana it was objected that the state had no minerals and that such a survey would be worthless. To-day Louisiana is known to have the largest sulphur supply in the world, and already ships more than half of all the sulphur that is used; it has the largest available supplies of salt, its oil fields are just beginning to be developed, it has gas fields now coming under control, it has thousands of acres of excellent lignite and some coal and it also has marble quarries, so that it is really perhaps the most interesting state of the Union to the gealogist. Bulletin 7 of the Geological Survey of Louisiana has recently been issued, a handsome volume of 260 pages with numerous half tones and maps. It is devoted chiefly to salt, especially rock salt, of which the store is enormous.

STIMULATING WITH OXYGEN

Oxygen as a stimulant for athletes and a general bracer under strenuous conditions seems to be in quite common use in England, where it is hailed as almost as great an asset as long and severe training. The half-tone, from the *Illustrated London News*, shows a team of English football players inhaling oxygen before the game. In Maude Adams' play "What Every Woman Knows," the hero in an exciting electioneering scene takes a pull at an oxygen tank. Dr. Leonard Erskine Hall, lecturing at the London hospital, insisted that men who inhale oxygen before making extreme efforts are more likely to win games and break records than those who do not. He set two students boxing at the hospital, one a trained man and the other a novice. At the end of the second round the untrained man was tired out, when oxygen was administered and he began work again almost as fresh as at the beginning.

ROCK DRILL SHARPENING ARRANGEMENTS

Drill sharpening presents a department of mine costs to which no attention is given by stockholders, and only a moderate degree of attention by the mining companies. An important step was taken several years ago in reducing the cost in this department by the invention of mechanical drill sharpeners, actuated by compressed air, which have now been introduced in the shops of nearly all the mining companies, but aside from this the companies themselves took no step to economize along this line except to introduce the machines and thus reduce the labor costs.

A radical departure is now being introduced, however, at a number of mines that will bring about even a greater saving than was secured when mechanical drill sharpeners were introduced. This is to alter the system of handling the drills. To show the comparison of the new system with the old, the method formerly employed will first be enumerated.

The drills are assembled underground by the drill boys, loaded on skips and hoisted to the surface. The ordinary rock skips are generally used for this purpose, and at times the long drills create a factor of danger, projecting above the skip bail and occasionally catching in the walls of the shaft.

At the surface the drills are piled out upon the floor by the drill boys, generally in a disorderly heap, which at times bends the steel so that it has to be heated and straightened, thus drawing its temper. Some of the companies have special skips, with compartments in which the steel is laid in an orderly manner and thus the danger of catching and bending is removed.

The drills are then loaded into wagons, in most cases, and hauled by teams to the drill shop, where from two to half a dozen drill sharpening machines are employed, depending on the size of the mine. Each team, driver and helper in this service costs about $5.50 per day.

After the drills are sharpened they are returned to the underground service by reversing the steps already described. This method requires that the drills be handled from six to ten times. Each drilling machine underground requires about 1,500 pounds of drills every 24 hours, and the cost of sharpening will at times reach $7.50 per day to keep the drills of one machine sharpened.

A complete change in this system is now being devised, to be introduced later. There is being installed in each shaft house a drill sharpening shop, consisting of a fireproof room, a forge and a drill sharpening machine, with the few other necessary tools. Two drill skips will be provided at each shaft, with compartments in which the drills will be kept assorted by lengths. When a skip load of drills comes to the surface it will be detached from the hoisting cable and shunted from the tracks of the skipway into the sharpening shop, which will be inside the shaft house structure and not 20 feet from the collar of the shaft.

In the shop will be an empty drill skip, and as each drill is taken from the loaded skip and sharpened it will be placed in the empty, until the latter is full and ready to attach to the hoisting cable to be lowered into the mine, leaving the former loaded skip empty and ready for the next consignment.

There will be only one to three hours' work at each shaft, according to the volume of rock, and the sharpeners and helpers will make their rounds from shaft to shaft handling the work. No one will be employed in the service except the drill boys necessary to make the underground distribution and the necessary sharpeners and helpers on the surface.—*Copper.*

HEART ACTION AT HIGH ALTITUDES

Dr. I. N. Hall, in the *American Journal* of the Medical Sciences, says that the dangers to the heart in high altitudes are the same as in other places, but are greatly exaggerated in some directions. The troubles most common and serious, he says, relate to inflammation of the heart muscle, hardening of the arteries, and dilatation of the heart.

The principle applied is this: The heart and lungs have an increase of functional work with each added degree of elevation and the consequent decrease in atmospheric pressure. To meet the increased demand on the circulation, the heart must enlarge if the usual amount of exercise is taken. It is not unusual for acute dilatation of the heart to occur after slight effort on the part of those whose arteries have begun to harden, and who long have been accustomed to atmospheric pressure at the sea level. The trouble with those who suffer in high altitude, the writer declares, is that they try to do too much at first, when they feel invigorated by the bracing atmosphere.

Dr. Hall adds that even an ascent in a railway train may be fatal to those who have but a narrow margin of heart strength, or the slightest exertion at such a time may produce angina pectoris. The average case of well-compensated valvular disease will do as well at a high altitude as anywhere else if the patient observes proper precautions. In such a climate he is less susceptible to acute rheumatism.

A PRECOOLING AND AIR DRYING APPARATUS

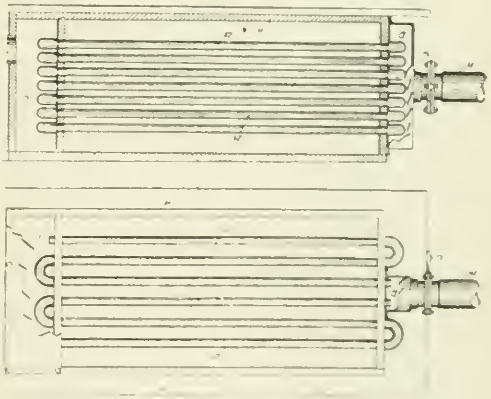
The transportation of fruits and vegetables and the delivery of them without deterioration involves much care and the employment of special methods The ice-cooled car has become a necessity, and in connection with it means are now employed for the initial cooling of the load. The little half tone here reproduced from *Ice and Refrigeration* shows a portable apparatus connected by large air pipes to a loaded box car, its function being to thoroughly cool and dry the load before the trip begins.

PRECOOLING A CAR LOAD.

The apparatus may be easily moved about as required or it may be mounted on wheels. The large box is fitted with coils of pipe connected with an air-tight chamber at each end of the machine. The space between these pipes is filled with 4,000 pounds of crushed ice, mixed with 500 pounds of calcium chloride or salt. An exhauster with a capacity of 3,000 cubic feet of air per minute is connected with the air chamber next to car door; the exhauster is operated by a high-speed gasoline motor running at a speed of 2,600 revolutions per minute. The insulated suction pipe is fitted to a plug covering an opening over the ice tank of the car and connected with the intake air chamber at the end of the machine opposite exhauster and engine.

The operation is described as follows: When the engine is started 2,100 cubic feet of air per minute, which is slightly more than the entire car contains, is drawn or sucked out of the top of the car, and in passing through the sets of piping in the machine is chilled to a temperature below freezing. The machine is first run a few minutes before connection is made with the car door, so that all heated air and gases generated by the freshly loaded hot fruit or vegetables is removed, and its place taken by pure air. The discharge pipe is then connected through a false door of the car and the chilled dry air is forced into the car, passing through its contents, and is again returned to the machine, maing a continuous circuit. As this air strikes the cold pipes all the moisture it contains congeals, so that only thoroughly dry, chilled air goes into the car. This constant renewal of all the air in the car each minute with the great speed of its passage and low temperature, rapidly extracts the natural heat from its contents, reducing the temperature from 85 degrees or 90 degrees down to from 40 degrees to 45 degrees in one hour or less, and eliminating all excess moisture, thus enabling the ice contained in the car to hold down the temperature, prevent incipient fermentation and secure the safe and sound arrival of the contents at destination.

For pre-cooling wrapped fruit and vegetables in crates, etc., a machine of double the above size is built, which has a capacity of 6,000 cubic feet of air per minute. The larger machine has two tanks connected together, with a double exhauster, operated by one engine It has a connection at the top of each end of the car instead of one end only, as shown in view.



PLAN AND SECTION OF COOLING PIPES.

The inventor of the machine is John D. Cunningham, Cincinnati.

NATIONAL VALUE OF CANALS

[The writer of the following, from the Augusta (Ga.) Herald, seems not to have heard of the New York State Barge Canal. Ed. C. A.]

France is preparing to spend $120,000,000 to construct a canal from Lyons to Arles, and $16,000,000 additional for building a branch to Marseilles. Russia, just passed through a disastrous war and a still more disastrous internal upheaval, is perfecting a gigantic plan for connecting the Baltic with the Black sea by a canal. England, so small, as to be accessible at almost all points from the ocean, yet completed the great Manchester canal only a few years ago, and while Germany dug the Kiel canal. Almost in all countries the value of canals is appreciated and canal building is being pushed, except in our own country.

It is true we are digging the Panama canal, the greatest canal enterprise ever undertaken. But this canal is not in our country. It is a thousand miles from our nearest port, and except for military purposes will be of as great benefit to other countries as to us. Of canals to develop our country we are digging none, nor are we seriously planning to dig any.

Yet canals are the greatest developers. It was her canals which made Holland, a little old marsh, a world power. It was her canal which enabled China to reach a high stage of civilization a thousand years before northern European civilization began. It was the Erie canal in New York which gave that state the lead over Virginia, superior in every way and the leader until this canal was built. Canals and national progress have always been closely connected.

In the great international trade and industrial competition we are allowing ourselves to be handicapped by not developing inland water transportation—which is and must always remain the cheapest—as is being done by competitor countries.

BAMBOO FOR AIRSHIPS

To the Filipino, as to most dwellers in the tropics, the word "bamboo" means a great deal more than it does to the inhabitant of a temperate climate Where an American or a European would use oak, pine and chestnut, or iron, steel and brass, the Filipino uses bamboo. The importance of this product to the inhabitants of the tropics cannot be underestimated.

The name "bamboo" was originally a Malay word, but has been adopted, with slight variations, by all the world. It applies to hundreds of different kinds of grass, as well as to trees one hundred and seventy-five feet high. Yet all the varieties called bamboo are the same in structure and can be used for similar purposes. Java produces the species growing to the greatest height and the stems of these gigantic growths often have a diameter of eighteen inches.

The house of the average Filipino is built of bamboo, from the corner post to the roof. In many cases, split bamboo, overlapped, takes the place of nipa palm roofing. This forms an excellent watershed. Walls, partitions, floors, and doors are of the same material, as is the fence around the yard and the steps leading to the house.

Within doors one finds chairs, tables, beds, hammocks, stools, ladders and cupboards made of the stems of this giant grass. Milk jugs, water pots, waterpipes, flower pots, bottles of every size, boxes, cups, and fruit jars are fashioned from joints of bamboo.

Bamboo is not only lived in and eaten from, but is likewise eaten and worn. The flower of the plant makes an edible dish. The fibers of the stalk can be shredded and woven into cloth, rugs, and carpets. The cloth made of bamboo makes cool, comfortable and durable clothing. Excellent paper is made of this fiber.

Recent developments have created an entirely new demand for bamboo. It is peculiarly adaptable for airships. No other common wood is so light and at the same time so strong. Steel tubing, spruce, bamboo, and aluminum tubing have all been used to hold the engines and other mechanisms necessary for aerial navigation. Steel and aluminum tubings are objectionable on account of their weight in comparison with the woods, and recent experiments show by laboratory tests that bamboo is stronger than spruce.

Of the total estimated power at present produced by prime movers in the United States about 26,000,000 H.P. are produced by steam engines, 3,000,000 H.P. by water motors, and 800,000 H.P. by gas and oil engines.

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EVERYTHING PNEUMATIC

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MILK

The routine of nature provides all our sustenance, but all which goes to the upbuilding and maintaining of our bodies requires more or less elaborate preparation by ourselves before it can be used. Except milk. Potatoes are absolutely uneatable until they are cooked. Wheat and corn must be ground and sifted and mixed and raised and kneaded and baked. Meat and fish must be boiled, stewed, roasted or fried, and so with all the other good things of the table. Milk, however, as a food is unique. Not only does it require no preparation, but so far as possible nature insists that nothing whatever shall be done to it before it enters the human stomach. In our primal and only absolutely correct use of milk three or four conditions are imperative: Milk shall not come in contact with the air and there shall be no adding to it or taking from it any ingredient; it shall be taken warm or at the normal temperature of the body, and it shall be imbibed slowly.

How completely we ignore all these conditions. We assume first that as milk is a food which nature provides for immediate and constant use it must be all right and can never be used improperly or possibly do harm; and so people drink ice cold milk by the tumblerful, and do with it other outrageous things, and when it upsets some digestive function, as it is very apt to do, the milk itself, and not the conditions of its imbibition, is assumed to be at fault, and suggestions multiply for its correction or improvement.

Surely this is all wrong. While we ignore or contravene the conditions of use upon which nature is so insistent we are not in a position to assert in any case that the milk itself requires, or can be improved by, any artificial treatment. Of course for purposes of storage and transportation the maintenance of a low temperature for the milk between its production and its consumption seems to be the best way yet discovered, and nothing is suggested in opposition. In addition to this our efforts can best be directed to the preservation of the milk in absolute purity from the moment of discharge from the animated fountains. Only when this is properly done can we rightfully begin to suggest that milk may be made safer or more nutritive and satisfying by manipulation.

For the securing of milk in its purity and for its preservation from contamination the pneumatic devices which are coming into use seem to offer the most perfect guarantees. In our issue for August, 1908, page 4974, we described a pneumatic milker, now in extensive practical service, by the use of which the milk is transferred from the cow to the air tight pail without exposure to the atmosphere, and in the issue preceding this, page 5286, we are told of an air tight milk delivery can which may be filled at the dairy, hermetically sealed and kept in this condition until the entire contents of the can are discharged at the place of sale, sterilized compressed air expelling it in uncontaminated purity. Such milk service would seem to be the best yet attained.

THE CANALS OF GERMANY

The following striking appreciation of the canals of Germany comes to us from the pages of *The Contractor,* Chicago. It is perhaps as good a word as has been said for the New York State Barge Canal now in progress. At the same time in connection with this it would be worth while to look back to "The Railroad Side of it," in our April issue, page 5253.

It is said that the mileage of the inland waterways of Germany, if possessed by the United States *in proportion to our area,* as compared to that of Germany, would be equivalent in lineal measurement to 40 parallel waterways east and west from the Atlantic to the Pacific, and 20 parallel waterways north and south from Canada to the Gulf; and that would mean a net work of canals for a state like Ohio, say, running east and west and north and south, which would be something like 40 miles apart from boundary to boundary in all four directions.

It is with this policy that Germany has built up and is continually improving and extending her inland waterways. During the past twenty years it has expended $150,000,000 on her waterways, and it has now, in navigable rivers, canalized rivers, and inland canals, over 8,278 miles of navigable waterways. The German-Austrian and the Rhine-Elbe canals, already begun, contemplate the expenditure of nearly $350,000,000.

Regardless of the fact that the railroads are owned by the government, more properly perhaps on account of that fact, it is held an economic principle by Germany that means of transport should be open alike to all, and while the development of the railroads, contrary to the expectation of their early projectors, has made the owners of such roads the only carriers, the government of Germany, in competition with itself as a railroad carrier, is spending hundreds of millions of dollars on its canals that means of transport may be as free and open as they are upon its country roads and highways.

The Dortmund-Ems Canal, intended to divert some of the enormous Rhine traffic at Cologne, from Rotterdam to a German port at Emden, cost Germany $16,000,000. It is 116 miles long and 8 feet 3 inches deep. German commerce, during the past thirty years, has been the chief force in the remarkable prosperity of Rotterdam, Amsterdam and Antwerp.

An English political economist, after a thorough study of Germany's inland waterways, says:

"If the German waterways should be blocked for a year, the whole of Germany *would probably be ruined,* for Germany cannot live without her waterways. A further circumstance in favor of water traffic lies in this: That far more traffic can pass over a broad canal than can be sent over a railroad. It is, therefore, clear that transport by water is and must always remain, owing to its very nature, so very much cheaper than land transport, be it by road or rail; that railroads cannot possibly compete with properly organized, properly managed, properly planned, and properly equipped waterways. Hence it is economically wasteful not to extend and develop the natural and artificial waterways which a country possesses, and it is absolutely suicidal and criminal to let them fall into neglect and decay."

The Norcross marble quarry at Tuckahoe, only a dozen miles from the heart of New York City, is to be abandoned and all the machinery is being removed. The quarry has been in operation more than half a century. The last of the great buildings to be erected of the pure white stone is the Metropolitan Life Insurance Building in New York, the greatest all marble building in the world with the already world famous high tower faced with the same material.

TRADE PUBLICATIONS

Beam and Column Data, Northwestern Expanded Metal Company, Chicago, 36 pages, 3 by 6 inches. Formulas, diagrams, tables and general information concerning "expanded metal," usually as used for concrete reinforcement.

Hunt Coal and Ore Handling Machinery, C. W. Hunt Company, 45 Broadway, New York, 88 pages, 6x9 inches, 240 separate cuts and half tones. Various information pertaining to this important and highly successful line of industrial equipment is here presented in compact and attractive form.

Sullivan Air Compressors, Booklet 106, Sullivan Machinery Company, Chicago, 20 pages, 3¼ by 5½ inches. Slips neatly into a letter envelope; briefly describes, with dainty half tones, the chief character of the different styles of air compressors and other machinery built by the company.

Type K Freight Triple Valve. Instruction Pamphlet No. 5030, Westinghouse Air Brake Company, Pittsburg, Pa., 30 pages 4¾x7 inches, folding plates and stiff cover for the pocket. The company's Type K Quick-Action Quick-Service, Uniform-Release, Uniform Recharge Freight Triple Valve is described with clear instructions for its manipulation under various service conditions.

Telescope Feed Hammer Drills, Ingersoll Rand Company, 11 Broadway, New York, 28 pages, 6x9 inches. Fine half tones and line cuts. This treats of a line of rock drills of rapidly extending appreciation and use. They are light drills in which the steel does not reciprocate, but is held constantly against the rock and is struck by the hammer as in hand drilling, but with vastly greater rapidity. The telescope feed automatically maintains the constant pressure of the steel against the rock. Both the Ingersoll "Crown" and the Rand "Imperial" hammers are described, with their manipulation under various conditions.

AIR CURES WATER HAMMER

Water hammer in some of the large mains of the Detroit Water Works, where the direct pumping system is used, has caused the engineers much anxiety, but the trouble has been materially reduced by the application of an air chamber as described in the annual report of the engineer, Mr. George H. Fenkell. About half a mile from the pumps an emergency station was built and equipped with a 1000 cu. ft. air chamber, an air compressor, with electric motor and devices making the air pressure maintenance automatic. The air chamber is connected to two 42-in. force mains, and since it has been installed the pressure gages some miles distant on a 24-in. connecting main have shown a reduction of the pressure fluctuations from about 12 lb. to 3 lb., while the hammer on one of the 24 in. mains, to which the air chamber is directly connected, has been reduced from 10 lb to 4 lb.

CLAY

By W. N. Logan.

ORIGIN AND CLASSIFICATION OF CLAY.

Clay is a soft rock, smooth or greasy to the touch and, mixed with water, it can be molded into any shape. This property is called plasticity. Clay is a mechanical mixture of many minerals whose proportion varies greatly. Aluminous clays contain much kaolinite, the basis of clay. Clays may be sandy, limy, or rusty with iron oxide.

Loess is a silty material of fine particles of clay, sand and lime and some organic matter It may contain concretions of lime carbonate and fresh-water shells. Marl is a mixture of sand and limy material of marine or lacustrine origin. Shale is compressed clay. The decomposition and alteration of rocks containing silicates of aluminum are the sources of clay. The silicates, called feldspars, forming the principal constituent of granite and eruptive igneous rocks is a fruitful source The decomposition of these rocks is by water carrying carbonic acid which attacks the potash and soda in the feldspar Thus aluminum uniting with silicic acid forms silicates free from other bases which are carried away by waters. Aluminum silicates thus formed are kaolinite. This forms beds of rock called kaolin. It is the base of clays, whose purity depends on the percentage of this element. Numerous impurities are liable to be associated with clay and the value, or the contrary, of the impurities depends on the purposes for which it is used.

There are residual clays derived from rocks in place and transported clays, such as are found in streams, lakes, glacial deposits and banks formed by wind In the case of residual clays their depth depends on the amount of surface decomposition the rocks, such as granite, have undergone; rarely is this as much as 100 ft. The gouge commonly met in mines, resulting from decomposition of feldspathic porphyries, is a kaolin, usually containing too many impurities for use in chinaware. Clays now found in place and forming thick beds of hardened shale were originally transported by seas or other bodies of water. During the glacial epoch, rocks were ground to powder and deposited in beds by streams, forming residual clays known as "till."

USES OF CLAY.

Common brick needs no description. Vitrified bricks are made of clay shales for pavement; they are compact, non-porous, stony, very hard and stand much pressure. Fire brick is from highly refractory clay; tile clay from common clay or fire clay or both. Flue clay and stoneware clay are from clay or shale. China clay, or kaolinite, used for porcelain; cement clay used in manufacture of Portland cement is mixed with limestone, then pulverized, burnt to vitrification and reground to flour; paper clay, used as a filler for printing paper, wall paper, etc., is used in raw state; fuller's earth, used to refine crude oil; adulterant clay, used in soap, paint and food; terra-cotta, used for terra-cotta brick.

Weathered shales exhibit a higher degree of plasticity than the unweathered. The chemical compounds of clay are silica, alumina, iron oxide, lime oxide, magnesia and alkalies. Minerals in clay are kaolinite, silica, iron, gypsum, feldspar, mica and hornblende. The physical properties consist of structure and shrinkage; the color of clay is very variable.

A clay may be roughly tested in the field by its feel to the touch, odor when moistened, and taste. Plasticity is a valuable quality of some clays, so is the degree of fusibility. Bonding power is the power of a clay to hold together non-plastic materials. Tensile strength is the resistance clay offers to pull. *Mississippi State Geological Survey.*

THE DEEPEST METAL MINES OF THE WORLD

The deepest gold mine is the Victoria Quarts at Bendigo, in Australia; this mine has a vertical shaft that has been sunk to 4,300 ft. and a winze that is 225 ft. deeper, making the total depth 4,525 ft.

In California, the main shaft of the North Star mine at Grass Valley is down 5,400 ft. on the vein, which has a dip of 28 degrees, so that the maximum vertical depth is only 2,086 ft. The neighboring Empire mine has an incline shaft that is down 3,500 ft. on the vein but only 1,570 ft. vertically below the surface.

The Kennedy, on the Mother Lode, in Amador County, is one of the famous mines of California. The maximum depth attained is 3,254 ft.

On the Comstock, the deepest mining now in progress is on the 2,300-ft. level of the Ophir, which is 2,552 ft. below the Gould & Curry outcrop. The greatest depth attained on the Comstock was in a winze in the Mexican mine, which, before the flooding of the workings in 1884, reached down to 3,308 ft., or 3,554 ft. below the Gould & Curry outcrop.

On the Rand, the shaft of the Cinderella Deep is down to 4,200 ft. and that of the Jupiter to 4,230 ft. Johannesburg, before long, will have many deep mines. In Brazil, the Morro Velho shaft of the St. John del Rey has reached a depth of 4,264 ft.

But the deepest metal mines are still in the Lake Superior copper region. There the Red Jacket shaft of the Calumet & Hecla mine is 4,920 ft. vertical; while the Tamarack has two shafts over 5,000 ft. deep, namely, No. 5, which is 5,180 ft., and No. 3, which is 5,230 ft. vertical. These Tamarack shafts were sunk to extract ore from the copper lode first exploited in the Calumet & Hecla, and they cut a lode having a dip of 38 degrees at a vertical depth of 4,660 ft. By attaining a depth of one mile underground and by showing with what ease operations are conducted at that great depth, these Lake Superior mines have demonstrated that man is likely to be able to penetrate at least as profoundly into the earth as the ore persists.—*Mining and Scientific Press.*

WEALTH IN SAVINGS

Say! Have you read that book of Andrew Carnegie's yet? Well, it's called the "Empire of Business," and it's all right! All the way through he shows you've *got to save money!* I guess "Andy" knows what he's talking about when he says, "Be thrifty." Why, out there at Gary, Ind., in the new steel plant, the gas from the blast furnaces—gas such as for fifty years they used to manufacture Pittsburg's famous atmosphere with—is now all saved, every bit of it, and all the big machinery and electric lights are run from this gas. They get 500,000 horsepower right along, and they say they don't have to buy coal for power. It's pretty near like getting something for nothing ain't it? Of course, they have to put in a dust catcher and washing machines, so the gas won't spoil the machinery, but the fellow that won't spend a hundred dollars when it will save him fifty dollars a year is about ready for the scrap pile, in my opinion, when it comes to knowing what the word *investment* means.

Maybe old man Armour didn't *invest* some money out there in South Chicago for machinery and brains, too! Why now, they tell me, they've got the "by-products of pig" down to such a fine point that for every ton of hogs they buy they sell a ton and a tenth, counting the wrappings!

And I guess John D. is pretty wise to this saving game, all right. They used to pump petroleum, get some gasolene and coal oil out of it, and throw the rest away. But nowadays the old chemists dig down in their queer old laboratories, and then we hear of a new "vaseline" on the market, or a "non-fluid oil," or a new axle grease. And so it goes every year, more and more usefulness out of the same old stuff that we ordinary folks thought didn't contain anything new at all.

Whether we read about a chemist fellow, or the expert butcher, or the steel men that save money, they always use the term "by-product." Now, that sounds kind o' swell and dignified, but I guess it's all right when you think about it. "By" really means "on the side," or extra. Just like when you order roast beef, and the waitress hollers: "Potatoes on the side," why you get them for nothing. So "by-product," when you boil it down, just means that you get something where you used to get nothing, 'cause you had been throwing it away.—*Power and the Engineer.*

A WATERWORKS AIR LIFT

An interesting air lift pumping plant is in operation as part of the water supply of Palmerton, Ontario. There are two 8-in. wells 300 ft. deep in a limestone stratum, the water normally rising to within 16 ft. of the surface. A 5-in. discharge pipe is placed inside the casing with a 1½-in. air pipe discharging at a depth of 100 ft. The compressor is a duplex machine with 12x12 in. air cylinders, the steam end being compound and condensing, so that good economy is secured. In a 10-hour test each pump delivered 250 gallons per minute, lowering the water level from 16 to 40 ft., at which depth it remained. When discharging 450 gallons per minute with an average lift of 39 ft. the free air used was 0.38 cu. ft. per gallon.

NOTES

The forty-second annual convention of the American Railway Master Mechanics' Association will be held on Young's Million Dollar Pier, Atlantic City, N. J., Wednesday, Thursday and Friday, June 16, 17 and 18, 1909.

The forty-third annual convention of the Master Car Builders' Association will be held at the same place Monday, Tuesday and Wednesday, June 21, 22 and 23, 1909.

The San Francisco branch office and warerooms of the Sullivan Machinery Company are now located at 461 Market street, in the Sheldon Building, instead of at 26 Fremont street, as heretofore.

In the New York Singer building or tower there are three elevators which travel 470 feet, and one, which is the highest rise elevator at present in use in a commercial building, rises 546 feet, to the 40th floor

According to the reports of the geological survey, 58.000.000.000 cubic feet of coal gas was made in the United States during 1907 by 513 companies. Of this product 54.000.000.000 cubic feet was sold for $30.327.807.

Small air hoists mounted on a bar are used in some of the mines at Mount Morgan, New South Wales, Australia. These are easily put up, the bar being placed vertically, and are used instead of a windlass in sinking winzes.

Until recently the deepest borehole in the world was that at Rybnik, Upper Silesia, 2.003 meters (6.571 feet). At Cruchow in the same district a hole commenced in December, 1906, with a diameter of 16 inches has now reached a depth of 2,156 meters and it is to be continued if possible to 2,250 meters, or 1.4 mile.

The breaking of an air brake hose recently caused the wreck of a freight train at Elmira, N. Y. The cars in the middle of the train buckled, two of them being forced into a vertical position and falling over against a two story wooden house. The crash of the cars and the subsequent wrecking operations completely demolished the house.

A plan for a tunnel below the St. Lawrence River at Quebec was recently submitted to the Montreal Board of Trade. It is claimed by Mr. J. S. Armstrong, the engineer who made the proposal, that it would cost no more than the proposed Quebec bridge, and that it would have the advantage of presenting no obstruction to navigation. Provision would be made for four lines of railroad track and for vehicular traffic.

Organic remains in sandstone are sometimes replaced by copper, such as fossil imprints of plants, branches and trunks of trees and bones of animals. Copper solutions have a natural affinity for organic substances. Silver also is sometimes found replacing organic remains. Tin solutions from tin deposits have replaced ancient deer horns in Cornwall. In the Silver Reef sandstones of Utah, chloride of silver replaced fossil plants.

A cupola frequently melts best on a very cold winter's day. The reason is that, if the blower takes air from out of doors, the moisture has been frozen out of the air. The cold also makes the air more dense. With each revolution of the blower the cupola then gets an increased quantity of oxygen with less than the usual amount of moisture, conditions which tend to produce a hotter fire and more uniform working.

The first operation in this country upon a human being in which the cavity of the thorax was opened while the lungs were inflated from a chamber containing air at a greater pressure than that of the atmosphere was performed recently at the German Hospital by Dr. Willy Meyer. Many operations in the thorax have been difficult to perform, and others impossible because as soon as the cavity of the thorax is opened the lungs collapse because of the atmospheric pressure.

There are grown in the United States about 13,000,000 bales of cotton annually, each bale weighing 500 pounds, which amounts to six billion, five hundred million (6,500,000,000) pounds of cotton. For every pound of cotton there are 3 pounds of seed, giving a yield of 19,500,000,000 pounds of seed, valued at about $200,000,000. There are about 800 cotton-oil mills in the United States.

Prof. Charles B. Richards, for the last twenty-five years head of the mechanical engineering department in the Sheffield Scientific School, Yale University, has announced his intention of resigning. He was one of the founders (1880) of the American Society of Mechanical Engineers and was Commissioner to the Paris Exposition of 1889. While not yet thirty years old, and working as a consulting engineer in New York, impelled by Charles T. Porter, he invented the modern steam engine indicator, for which invention he received the decoration of the Legion of Honor of France.

The C. & G. Cooper Company, Mount Vernon, Ohio, recently forwarded an entire trainload of machinery comprising a single engine for the Tenn. C. I. & R. Co. at Eusley, Ala. This was a 42 and 78x54 inch cross-compound condensing Cooper Corliss engine. Delivery was promised in four months from receipt of necessary information, but it was made forty days ahead of time. It is to drive a 2,500 kilowatt Crocker-Wheeler alternator and is proportioned for heavy overloads. A similar engine is being completed for the Packard Motor Car Co. of Detroit.

The rock temperature in Bendigo mines, according to the report for 1907 of A. H. Merrin, chief mining inspector for Victoria, Australia, increases at the rate of 1 deg. Fah. for each 75 ft. below the zone of invariable temperature. At 4000 ft. the temperature due to the heat of the rocks is 110 deg. Fah. At this depth the temperature of the water issuing from the rocks is 114 deg. Fah. Under average underground conditions, when there is water in the downcast shaft, the actual temperature in the stopes will be somewhere between 75 deg. and 110 deg. Fah., depending upon the quantity of air entering the stope and the length of time the air is in contact with the rock before entering the stope.

One of the great scourges of mining is miner's phthisis, or miner's consumption, a disease formerly thought to be caused largely by dampness, cold or powder smoke, but now known to be caused by rock dust inhaled into the lungs. The fine, sharp particles of the dust become imbedded in the air cells of the lungs and set up an irritation that often results seriously. The trouble is in no way due to poisonous ingredients of the mineral matter, but entirely to the mechanical irritation. Miners in metalliferous mines are particularly subject to miner's phthisis, as the dust produced in these mines is often hard and glassy, and it has been noted that in mines where this dust is most common this disease is most prevalent.

A ship canal across Scotland is now being discussed. At the present time there are two waterways across Scotland. One of them is the Caledonian canal, which has a large number of locks and will receive vessels up to 160 ft. in length. The other is the Forth and Clyde canal, 39 miles long, 27 ft. wide at the bottom and 10 ft. deep, which was opened for traffic in 1790. None of the projects under discussion relate to the Caledonian canal, but there are several with regard to the other. One of them is to enlarge it to accommodate the heaviest battleship of the navy, and the other is to alter it into a tidal canal with hydraulic lifts at each end. Other plans for a ship canal have been proposed.

In the metric system fluid pressure, as of steam, air, etc., is stated in kilograms per square centimeter. One kilogram per square centimeter is equal to 14.22 pounds per square inch, and this number is used as a multiplier in converting the metric reading into English. For converting inch-pound pressures into metric the reciprocal of this number, .070323, is the multiplier. The kilogram per square centimeter is inconveniently near to the normal atmospheric pressure at sea level, 14.22 being about 3.3 per cent. less than the 14.7 pounds usually assumed. The atmospheric pressure at an altitude of 800 feet is very nearly a kilogram per square centimeter.

If the specifying architect would only take the trouble to inquire a little, he would find that American quarries produce every possible requisite for the most elaborate trim, as well as the most attractive body stone, for every structure. The development of our quarries a generation ago was insignificant compared with that of to-day. No industry has shown anything like a comparative improvement during the last decade with the stone producers of this country. With better equipment and raw material fully as good or better than foreign quarries can show, American quarries now offer selections that outrank the world.—*Rock Products.*

An interesting demonstration was recently given in England of an electric-generating plant operated by a windmill. The wind wheel was 16 feet in diameter, and was mounted on a tower 50 feet high. Three tails were provided, one at the side being fixed, and the other two adapted to be rotated on a horizontal axis, so that when they were turned into the vertical plane they would hold the wheel into the wind, and when turned in the horizontal plane, the fixed tail would throw the plane of the wheel in the plane of the wind. The two movable tails were arranged to swing out of the vertical position, automatically, when the velocity of the wind rose above a certain amount. A two-kilowat generator was driven by the wheel at speeds varying from 800 to 1,600 revolutions per minute.—*Scientific American.*

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

APRIL 6.

916,999. AIR-HEATER FOR GASOLENE-ENGINES. CHARLES B. CHAMBERS, Milo, Mo.

917,071. PNEUMATIC-TIRE VALVE. THOMAS B. HUESTIS, Bristol, R. I.

917,074. ROCK-DRILL. CORWALL JACKSON, Madison, Wis.

917,081. COMBINED MOTOR AND AIR-COMPRESSOR. WINCENTY KRYGOWSKI, Chicopee Falls, Mass

1. In an apparatus of the character described, a reservoir for compressed air, and a combined motor air compressor *internally of the reservoir*, the compressed air delivery conduit terminating within the reservoir.

917,091. AIR-BRAKE SYSTEM. George Macloskie, Schenectady, N. Y.

917,185. APPARATUS FOR TEMPERING AND PURIFYING AIR. William E. Taylor, Toledo, Ohio.

917,193. FLUID-PRESSURE BRAKE. Walter V. Turner, Edgewood, Pa.

917,194. FLUID-PRESSURE BRAKE. Walter V. Turner, Edgewood, Pa.

917,242. PNEUMATIC HAMMER. Joseph Boyer, Detroit, Mich.

917,300. FLUID-PRESSURE CONTROLLER. William G. Hughes, Pittsburg, Pa.

917,317. AIR-ENGINE. Christopher John Lake, Bridgeport, Conn.

917,345. FLUID-PRESSURE-CONTROLLING VALVE. Frank A. Nelson, Minneapolis, Minn.

917,445. TROLLEY. Albert S. Janin, New York, N. Y.

1. In trolleys for locomotives and trains, a collapsible diamond-shaped frame, spring and pneumatically controlled, and an auxiliary lifting device for the frame, said lifting device serving as a cushion for the frame when lowered.

917,619. AIR-DRIER FOR PNEUMATIC LINES. James L. Lamb and Timothy C. Sheehan, Philadelphia, Pa.

1. An air drier for a pneumatic system comprising a perforated surface and a mass of mechanically absorbent spongy material interposed within the line of traverse of the air of the pneumatic system, the spongy material being supported upon the perforated surface, whereby the moisture which has been removed by the spongy material from the air is in turn drained from the spongy material.

917,647. WAVE AND TIDE MOTOR. Elbert T. Odom, Birmingham, Ala.

917,688. PNEUMATIC HOIST. Bruce Walter, Pittsburg, Pa.

917,695. AIR-SHIP. Harry Wells, Oakland, Cal.

917,731. ROCK-DRILL. Corwill Jackson, Madison, Wis.

APRIL 13.

917,756. HOT-AIR HEATING PLANT. Robert G. Elliott, Toledo, Ohio.

917,897. AUTOMATIC CONTROLLING MECHANISM FOR FLUID-PRESSURE SYSTEMS. Walter J. Richards, Milwaukee, Wis.

917,935. VESSEL-PROPELLING APPARATUS. John Elniff, Kansas City, Mo.

1. A vessel provided with a plurality of ports in its hull below the level of the water on which the vessel floats, plates secured externaly to the vessel near said ports having channels communicating at their opposite ends with said ports and the water sustaining the vessel, certain of said channels communicating with the water sustaining the vessel, at their front ends and the remainder at their rear ends with respect to the prow and stern of the vessel, and *means for forcing air* through said ports and channels.

917,942. WINDMILL. Thomas O. Harstad, Windom, Minn.

917,974. TUNNELING-MACHINE. Edward F. Terrey, New York, N. Y.

917,992. FLUID HOISTING MACHINERY. Clinton F. Blake, Chicago, and Christian W. Aveling, Morgan Park, Ill.

917,993. DUST-REMOVING PNEUMATIC MACHINE. Jules R. Blum, Paris, France.

918,089. GAS AND OXYGEN BURNER. Hermann Riess, Reinickendorf-West, near Berlin, Germany.

918,194. ELECTRIC AIR-COMPRESSOR. Augustine J. Pocock and Richard E. Allgire, Dayton, Ohio.

918,336. AERIAL NAVIGATION. Christopher John Lake, Bridgeport, Conn.

1. In a vessel or vehicle, the combination of longitudinal air passages and substantially vertical air passages, each of said passages having a contracted central portion and expanding in either direction therefrom to enlarged open ends, means for producing a heated elastic fluid under pressure and means for discharging said fluid from points intermediate the ends of the conduits, and their contracted central portions in such manner as to impel air therethrough, the air being heated and expanded by said fluid during its traverse of the expanding portions of the conduits.

918,410. AIR-SHIP. James M. Wright, Keokuk, Iowa

918,468. ART OR PROCESS OF PRODUCING LIQUID AIR. James F. Place, Glenridge, N. J.

918,470. AIR-BRAKE. Edmund B. Powers, New York, N. Y.

APRIL 20.

918,510. TUNNEL-VENTILATING DEVICE. Howard Constable, New York, N. Y.

918,574. AIR-CLEANING SYSTEM. William C. Mayo and John Houlehan, El Paso, Tex.

918,589. APPARATUS FOR SEPARATING NITROGEN AND OXYGEN FROM MIXTURES CONTAINING THEM. Raoul P. Pictet, Berlin, Germany.

918,596. MEANS FOR PROTECTING SUBMERGED MOTORS. Henry G. Reist, Schenectady, N. Y.

1. In combination, an electric motor, an airtight inclosing casing therefor provided with an outlet near the bottom and a compressed air inlet, and a source of compressed air external to said casing arranged to force air into said inlet whereby the fluid in which the casing is submerged will not rise to a level in said casing much above said outlet.

918,652. DRIVING MECHANISM FOR PLANER-PLATENS. John H. B. Bryan, Buffalo, N. Y.

1. A driving mechanism for planer platens comprisng two pneumatic clutches which are constructed to move the platen in opposite directions, a main air supply pipe, two branch pipes or conduits connecting with said clutches, a reversing valve for connecting each branch pipe or conduit either with the main air supply pipe or with an exhaust, and means constructed to permit the air to flow freely forward through said branch pipes or conduits but retard the backward flow of the air through the latter, substantially as set forth.

918,675. AIR-BRAKE SYSTEM. John Hughes, Jackson, Mich.

918,754. AIR-BRUSH. Frederick J. Lederer, Buffalo, N. Y.

918,794. PNEUMATIC COTTON-PICKING SYSTEM. John S. Thurman, St. Louis, Mo.

918,795. SUCTION-HEAD FOR VACUUM COTTON-PICKERS. John S. Thurman, St. Louis, Mo.

918,879. COMBINED AIR AND GAS MIXER AND CONTROLLER. John H. Martindale, Cleveland, Ohio.

918,894. FAN-BLOWER. Amon T. Noe, Parnassus, Pa.

918,896. PNEUMATIC RENOVATOR. Amon T. Noe, Parnassus, Pa.

918,930. SELF-CLOSING VALVE FOR VACUUM CLEANING-TOOLS. John S. Thurman, St. Louis, Mo.

918,931. COMBINED DISINFECTING AND GREASE-REMOVING APPARATUS. John S. Thurman, St. Louis, Mo.

918,932. DUST-DISPLAY DEVICE FOR VACUUM CLEANING-TOOLS. John S. Thurman, St. Louis, Mo.

918,968. SUBAQUEOUS ROCK-BREAKER. Barton H. Coffey, Boston, Mass.

919,035. PNEUMATIC HAMMER. Victor E. Lane, Berwick, Pa.

919,079. SIPHON-PUMP. William L. Richards, Wilkes-Barre, Pa.

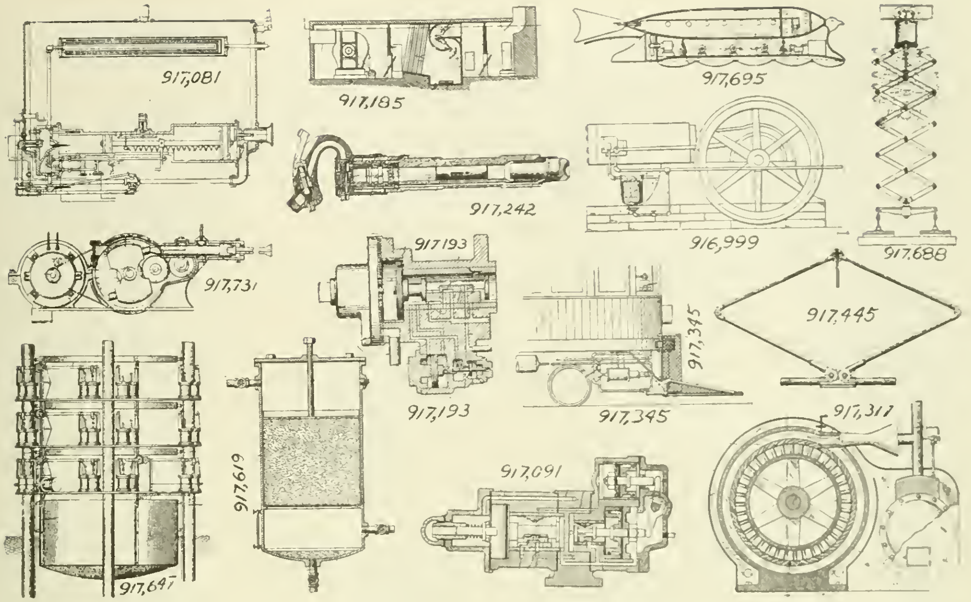
919,142. APPARATUS FOR PUMPING OIL FROM PETROLEUM-WELLS. Karel E. Ehrmann, Bajoeng Lentjir, Sumatra.

919,270. HAMMER-DRILL. Daniel S. Waugh, Denver, Colo.

12,945. PNEUMATIC TOOL. Wells Wheeler, Swissvale, Pa. (Reissue).

APRIL 27.

919,304. PNEUMATIC-DESPATCH-TUBE APPARATUS. Louis G. Bartlett, Somerville, Mass.



Pneumatic Patents April 6.

919,326. FLUID-PRESSURE MOTOR. Philip J. Darlington, Plainville, Conn.

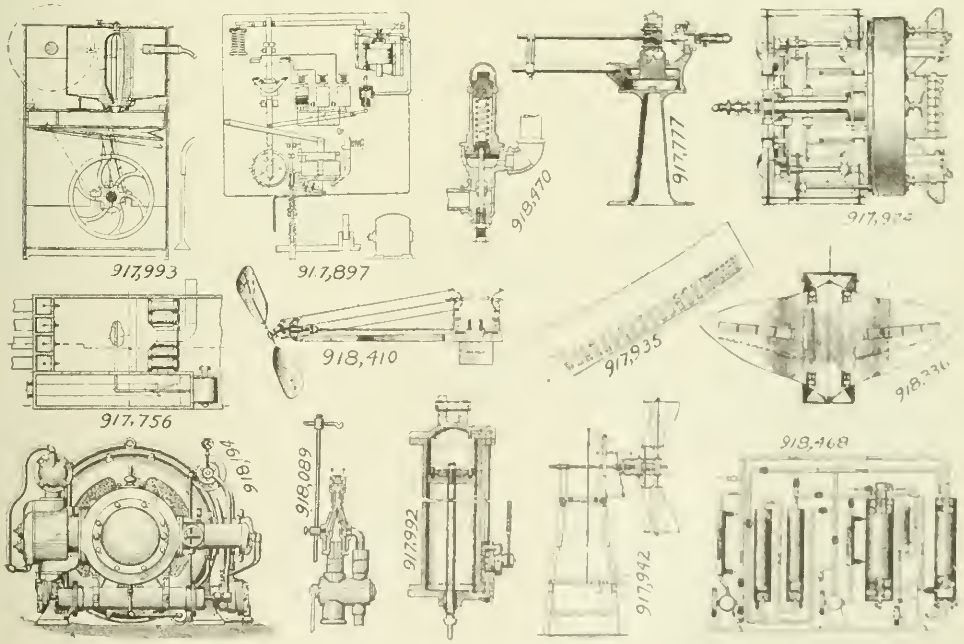
919,369. SUCTION APPARATUS FOR PNEUMATIC CLEANING SYSTEMS. William Locke, Westfield, and Elias Locke, Westfield, and Elias B. Dunn, East Orange, N. J.

919,403. APPARATUS FOR THE PRODUCTION OF OZONE. Alexander Vosmaer, Philadelphia, Pa.

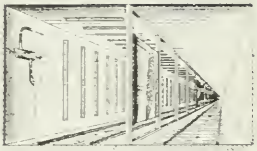
919,445. OZONIZER. Anthony Lohman, Philadelphia, Pa.

919,481. AIR PUMP OR COMPRESSOR. Charles O. Sobinski, St. Louis, Mo.

919,606. PNEUMATIC SUCTION CLEANING



Pneumatic Patents, April 13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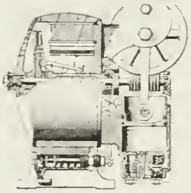
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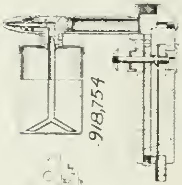
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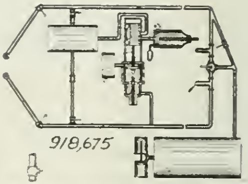
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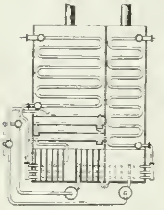
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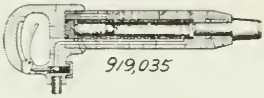
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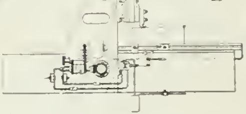
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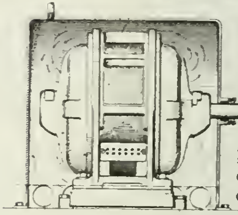
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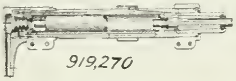
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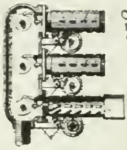
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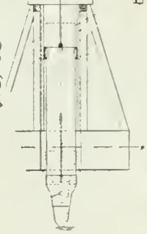
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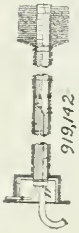
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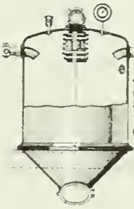
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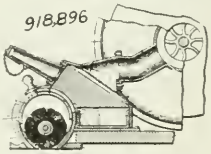
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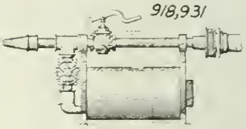
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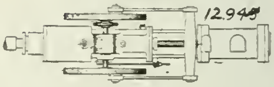

12,945

Pneumatic Patents, April 20.

APPARATUS. William Locke, Westfield, and Elias B. Dunn, East Orange, N. J.

919,609. AUTOMATIC AIR-BRAKE SYSTEM. George Macloskie, Schenectady, N. Y.

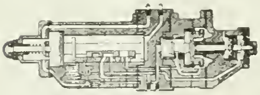
919,611. AIR-COOLER. Charles F. Martin, Little Rock, Ark.

919,658. AIR-VALVE. Victor C. Washburn, Clifton Springs, N. Y.

919,909. COMPOUND AIR-COMPRESSOR. Alfred H. Meech, Chatham, N. Y.

919,924. BUTTON-SET FOR PNEUMATIC HAMMERS. Arthur J. McQuaide, Canton, Ohio.

919,953. GOVERNING MECHANISM FOR AIR-COMPRESSORS. Richard H. Rice, Lynn, Mass.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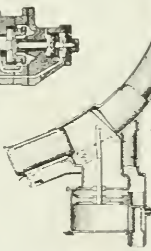
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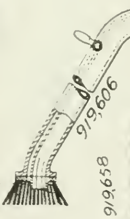
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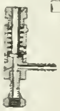
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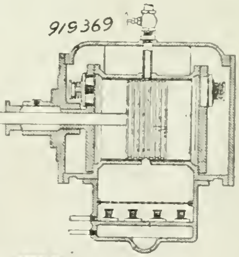
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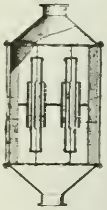
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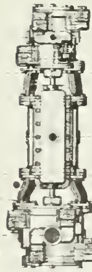
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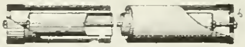
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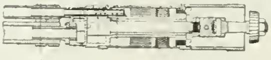
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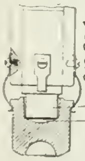
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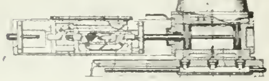
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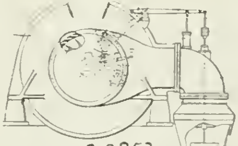
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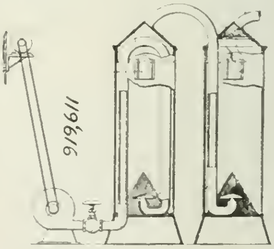
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Pneumatic Patents, April 27.

COMPRESSED AIR
MAGAZINE
EVERYTHING PNEUMATIC.

Vol. XIV JULY, 1909 No. 7

TYPICAL POWER DRIVES ON THE NEW YORK BARGE CANAL*

The traveler of the present, journeying through the valley of the lower Mohawk, has doubtless observed that at numerous points along the river extensive operations of an engineering character are being carried on, and he is told that the canalization of the Mohawk river, a leading feature of the 2,000 ton barge canal project, is now in full swing along the line.

Huge dams are planned to bar the river channel, and these structures being the major feature in the cost and difficulty of building the waterway, it becomes important that their construction should be first under way, not to delay the completion of the project in its entirety.

The cost of the various contractor's plants to build these structures amounts to no mean figure. Local conditions vary in nearly every instance, and to meet these conditions requires careful study on the part of the contractor and his engineers, in order to assemble the most economical and efficient plant with a minimum of expenditure in time and cost.

Three localities are here selected, at each of which the work and the conditions are different from the others, and the plant at each point varies in important particulars, though each is in some respects typical of its kind. These three plants are embraced within a single contract, that of the Acme Engineering and Contracting Company, and, therefore, under the ultimate supervision of a single set of officials.

An attempt has been made to have all apparatus conform as near as possible to some adopted standard, thus forming an equipment which may be used collectively or individually with the most economical results.

In order to maintain all apparatus in good condition, and to make all repairs as quickly and cheaply as possible, an efficient and complete machine shop was installed at a central point at Lock No. 7. Not only all the repair work from the several branches of the contract is done at this shop, as well as many small parts of derricks, etc., are manufactured and sent out to the various jobs, and it is seldom necessary to call upon an outside shop to do any of this work.

Three distinct systems of power development and distribution are in use at these points:

First, direct steam drive, furnished to the engines from small individual boilers located at various points on the work. This is the system ordinarily used on small contracts and is in operation at Dam No. 11, Lock No. 15, at Fort Plain.

Second, compressed air drive, furnished from a central steam driven compressor plant, located at a convenient point on the work. This plant is designed with the idea of producing steam to drive the compressors at the lowest possible cost, and so to overcome the loss of efficiency in the compressor and the loss in transmission to the engine. This system is in use at Dam No. 3, Lock No. 7, located a mile above Vischers Ferry

Third, compressed air drive combined with electric power. The compressed air is furnished from a central compressor plant driven

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*Condensed from *Barge Canal Bulletin.*

by a belt from an electric motor, and is used for operating hoists, drills, etc. Electric motors are used direct at various points on the work for driving pumps, stone crusher, tools in carpenter shop, etc. This system is in operation at Dam No. 2, known as the Crescent dam.

Each system has been entirely satisfactory under existing conditions, and at the same time the diversity of system has furnished an excellent opportunity to compare the strong and the weak points of each and determine the peculiar conditions to which it is especially adapted.

At Fort Plain, the most western of the three points, steam is used exclusively as previously stated.

The plant at Vischer's Ferry is especially interesting because it is at a central point of the contract as a whole. All the engines and pumps at this place are driven by compressed air, with the exception of one derrick. The compressor plant consists of two Ingersoll-Rand 24-in. steam, 26¼ and 16¼ air by 24-in. stroke straight line, two stage, class A C compressors driven by steam furnished by five 100 H. P. Erie City boilers of the portable return tubular type. These boilers are all connected into an 8-inch steam header, from which pipes lead to each compressor and to a small direct-connected electric generator. The exhaust steam from the compressors passes through an Erie City counter-current feed water heater. This heats the feed water nearly to the boiling point before it enters the boilers. The plant is so located that coal cars can be pushed upon a trestle in front of the boilers and unloaded very easily.

The free air is drawn into the low pressure cylinders from a screened box outside the building through 9-inch pipes. After being compressed in the low pressure cylinder to about 30 lbs. it passes through the intercooler to the high pressure cylinder. This raises the pressure to 100 lbs. and the air then passes through 6-in. pipes to the 5 ft. by 18 ft. vertical receiver located just outside the building. At this point the distributing system begins. The air leaves the storage in an 8-inch pipe which branches into two 6-inch pipes, and these in turn branch into two 4-inch pipes. Each 4-inch pipe leads to a separate part of the work and each is provided with a valve, so that in case of an accident to any part of the system it can be cut off and the other parts carried on without interference.

One line is taken to the machine shop, which is near, to run the 20 H. P. engine driving the shop, also, the 300 lb. steam hammer and the forges. A second line is taken along the side of the lock and provided with taps about every 40 feet. This line furnishes air for operating a 9 by 10-in. Lidgerwood hoist on a traveling derrick with an independent swinging engine, a 5-in. plunger pump and a 12-in. direct-connected centrifugal pump, also drills, etc., which are used in the excavation and in the placing of concrete in the lock. A third 4-in. line supplies the work in the main dam in a similar manner and terminates in a receiver on the island.

From the mixer on the island a railway runs along the cribwork of the upper coffer dam to the south side, with the usual outfit of locomotives and cars. Below the dam and railway run two other parallel tracks. Upon these, mounted upon suitable trucks, are two revolving derricks with 75 ft. swinging beams, similar to the derrick located on the work at the lock. The stiff leg of each derrick is supported upon a truck running upon one line of the railway, while the derrick itself rests upon the other line. These derricks use the air in 9-in. by 10-in. Lidgerwood engines.

A fourth 4-in. line runs directly from the receiver at the compressor house to the 5 ft. by 18 ft. receiver on the island. From this receiver another distributing system is started, consisting of a 3-inch line to each of the 12-in. by 15-in. cable engines and a 10-in. by 12-in. three drum hoist and a small swinging engine. These cables have a span of about one thousand feet with towers on the island 100 ft. high. Both have a capacity of ten tons and one is equipped with an aerial dumping device. The Hains concrete mixer is located at this point and material is fed to the mixer by a guy derrick operated by another 10-in. by 12-in. three drum Lidgerwood hoist.

It has been found necessary to reheat the compressed air at a point near the engines, except in very warm and dry weather, this reheating also greatly increasing its efficiency. The heating is accomplished by means of coils of pipe enclosed in a rectangular iron box supported above a set of grates upon which a small steady coal fire may be kept. All the reheaters are made at the company's machine shop at Lock No. 7.

The third location on the contract is still farther down the Mohawk, just below the entrance to the land line leading to the flight of locks at Waterford. Near the work here was found an outcrop of massive, close-grained rock which resembles, if it is not, trap. A quarry has been opened here, not far from the center of the work, and from this will be taken stone for building the dam, which otherwise must have been imported from elsewhere, while the spalls and fragments will be excellent for concrete. An Acme crusher has been erected and all the quarry equipment of drills and hoists is also operated from the general power system.

The plant here (Dam 2, Crescent) is a combination of steam, compressed air and electric drive. The hoists, drills, etc., are driven by compressed air, while small motors are used at several points on the work for operating pumps, stone crusher, tools at carpenter shop, etc.

Electric current is purchased from the Hudson River Electric Power Company and is supplied at 30,000 volts to transformers which reduce the voltage to 600. Various lines are taken from the transformers for use for motors and lights at all points of the work. Heavy wires are carried across the short distance between the transformer house and the compressor building to supply the 250 H. P., 600 volt, three phase induction motor used for driving the compressor. This compressor is an Ingersoll-Rand, class I C, belt driven machine with air cylinders 25¼ and 16¼ by 16 in. stroke having a capacity of 1,205 cu. ft. of free air per minute. The air passes from the compressor to the horizontal receiver outside through a 6-in. pipe. There are three distinct lines running from the receiver to the different parts of the work. One line, about 1000 ft. long, furnishes air for running the hoists and drills at the quarry. Another, about 1,500 ft. long, furnishes air for running two 10-in. by 12-in. three drum hoisting engines at the canal. Still another line supplies air for the work in the river.

The total equipment, then, driven from the air compressor consists of two 10-in. by 12-in. three drum hoisting engines used for unloading material and feeding the mixer, one traveling derrick used in excavating and placing concrete, two derricks in the quarry, three or four small pumps, and from one to eight rock drills. A McMyler traveling crane is used for excavating and placing concrete in the main dam, this machine having its own boiler.

The equipment of this work as a whole is an application of electric drive to the ordinary steam machinery. This is accomplished by using the electric power to drive the air compressor and then using the air in the ordinary steam engines.

COMPRESSED AIR VERSUS STEAM IN COAL MINING

By P. P. Glenn*

The most expensive and difficult operation in the production of coal is the process of loosening its solid state, and this is accomplished in three ways. First, by blasting it from the solid as is done in the Connellsville region. Second, by undercutting for blasting. Third, by shearing either in the center or on the rib, and shooting to the shearing. This method is used in many bituminous mines where there is a strong roof, and where the run of mine basis is used. There is, of course, some intermixing of those methods, as in some mines they both undercut and shear in order to protect a tender roof, and to get a large proportion of lump coal; for where the coal is both undercut and sheared on one rib it can be brought down with a very slight charge of powder. In some cases no powder at all is used, and the coal wedged down after being undercut and sheared.

Many machines have been constructed to undercut and shear coal, and they are now so perfect as to meet the various requirements found in the different coal fields that it may safely be said that compressed air coal cutting machines will in the future do the greater part of coal getting. The most successful of these machines may be divided into two classes, those which act percussively and cut with a single large chisel, and those which cut with a series of steel teeth The second class is subdivided into four classes, one of which may cut out a larger cylinder of coal, and which is used almost exclusively for driving headings. One of those machines, 'the Stanley header,' can cut out a cylinder of bituminous coal four feet in diameter and five feet in length in 15 minutes, and after making the necessary allowances for removals, a rate of advance equal to 75 feet per shift of 10 hours is accomplished. When it is necessary to drive wide entries, two machines may be worked, side by side, thus driving two parallel entries which nearly intersect each other. The thin pillar left between them can easily be cut with a pick. If the coal could be removed as quickly as the cutting is done, the machine could advance an entry 12 feet wide, 25 feet in 10 hours. As coal varies so much in hardness, and in the amount of impurities it contains, it is possible to give only an approximation of the cost of driving entry with the Stanley Header, which is about 25 cents per linear foot when a single cylinder four feet in diameter is cut out, operated by compressed air.

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*Scottdale, Pa., Mining Institute

Compressed air is much used as a motive power in place of steam for driving engines, pumping, and ventilating purposes, also for undercutting machinery and drilling. The principal of an air compressor depends upon the fact that when any given volume of air is compressed in a certain ratio, the absolute pressure or tension of the air is increased in the same ratio, in which the volume is decreased when the temperature remains the same. The compression of air, however, causes a rise of temperature in the air compressed, which increases the pressure in a greater ratio than that just given. In practice this increase of temperature is a detriment owing to the late cooling, and consequent loss of pressure in the transmission of the air to the point where it is to be used. Air compressors are designed therefore to maintain the temperature as nearly constant as possible during the compression.

The power is applied to an engine in the use of compressed air in the same manner as in the use of steam; steam engines are often operated as an air engine with but a slight arrangement of the valves. The advantage of compressed air over steam consists in the ease with which the power is transmitted to the working face. The losses due to the condensation of steam and the radiation of heat in a long pipe line are avoided where compressed air is used. In case of a break occurring in the pipe line, there is no danger of scalding workmen or animals, and the air exhausted from the cylinders of the machines on the roads or at the working face, is a benefit instead of being a hindrance, as is the case with exhaust steam. In the use of compressed air the power loss in transmission and compression can be retarded, wholly or in a part, by re-heating the air. In mine haulage compressed air motors possess the advantage over steam locomotives in that they require no fire, do not contaminate the air of the mine by gases of combustion, or run any risk of igniting the mine gases. In haulage the required pressures are necessarily high, ranging from 500 to 1,000 pounds pressure gauge. In this work compound compressors are better adapted, because where air is compressed in two, three, or four stages, a high pressure can be attained with a comparatively small range of temperature in the compressor cylinder, and the result is a greater saving of power.

Drilling and cutting machines, and pumps are generally operated under pressure ranging from 60 to 100 pounds per square inch. Mine motors are designed for high pressure up to 150 pounds per square inch at the throttle, the tank pressure varying from 600 to 800 pounds, while a pipe-line pressure varying from 600 to 1,000 pounds per square inch is commonly used in main haulages. It is good practice to provide a pipe line of sufficient size to pass the required volume of air at a velocity varying from 20 to 50 feet per second, and not to exceed 50 feet per second for good results.

LARGE AIR COMPRESSOR FOR SOUTH AFRICA

The half tone and several cuts here reproduced from *The Engineer,* London, and the description condensed from the same source, tell us of a large air compressor which has recently been shipped to Johannesburg by Alley and MacLellan, Limited, of Glasgow. This plant embodies several new features. Its duty is 5000 cubic feet of free air per minute net capacity, corrected for all losses, including heating, compressed to 100 lb. per square inch. There are three cranks arranged 120 deg. apart, over which are placed the trunk air cylinders. The compression is effected in two stages, the upper end of the cylinders being the intake. The final compression is carried out in the annulus formed under the trunk piston.

The motive power is obtained by means of three steam cylinders, one high and two low, 25 in. and 32in. diameter respectively, each of which is arranged tandem over an air cylinder.

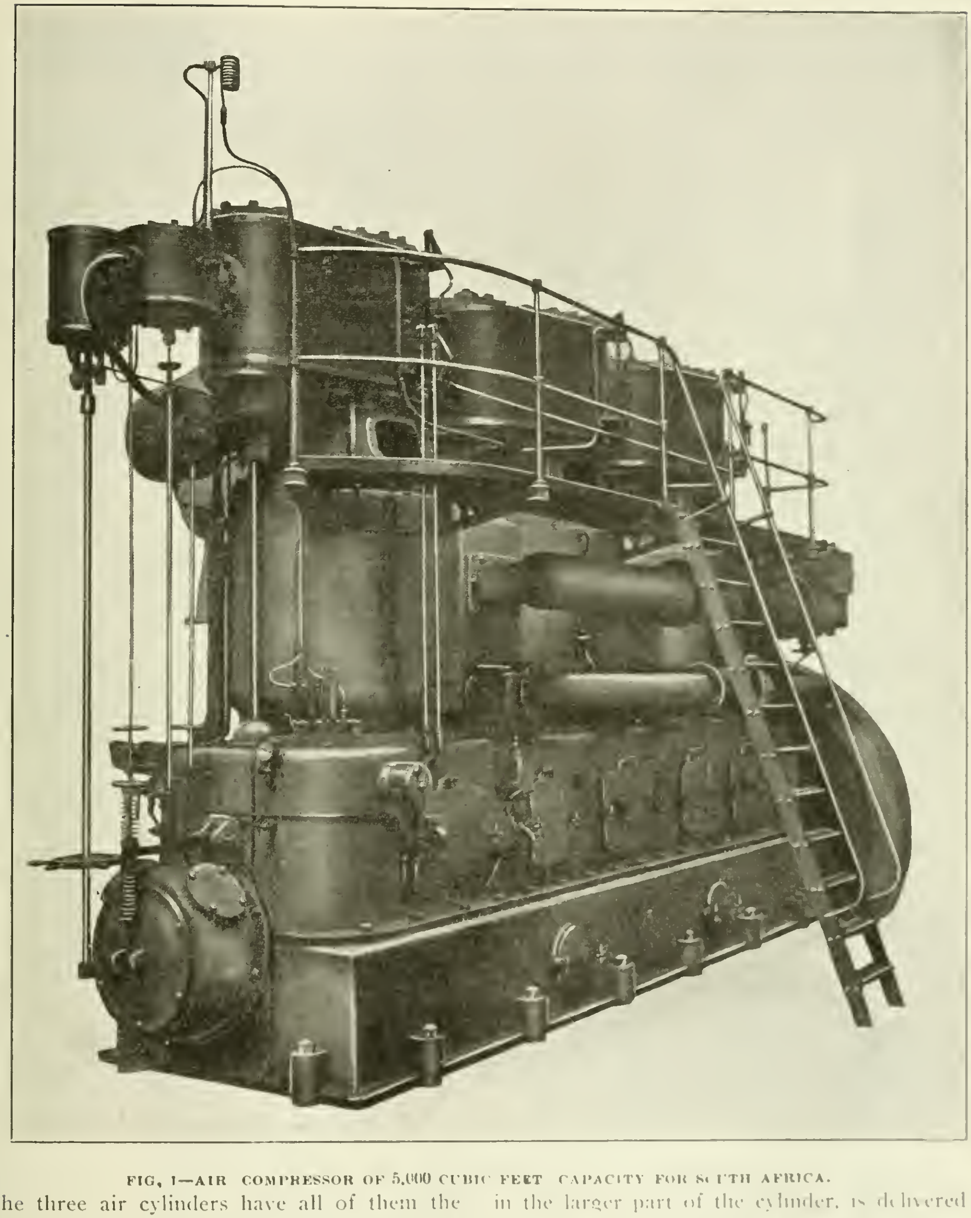

FIG. 1—AIR COMPRESSOR OF 5,000 CUBIC FEET CAPACITY FOR SOUTH AFRICA.

The three air cylinders have all of them the same dimensions. In the larger part they are 37in. in diameter and in the smaller $29\frac{1}{2}$in. The diameter of the piston-rod is $4\frac{1}{4}$in. The area of the larger part of the cylinder is therefore—allowing for the piston-rod—1061.014 square inches, and of the annulus 391.71 square inches. The stroke of both steam and air cylinders is 16in. The air, after being compressed in the larger part of the cylinder, is delivered to an intercooler, which has a cooling surface of 1000 square feet, before being further compressed in the smaller part. The compressor cylinders and their valves, which are of the piston type, are all heavily water-jacketed. A perspective view of a differential piston and its piston valve is given in Fig. 5.

The compressor is designed to give the

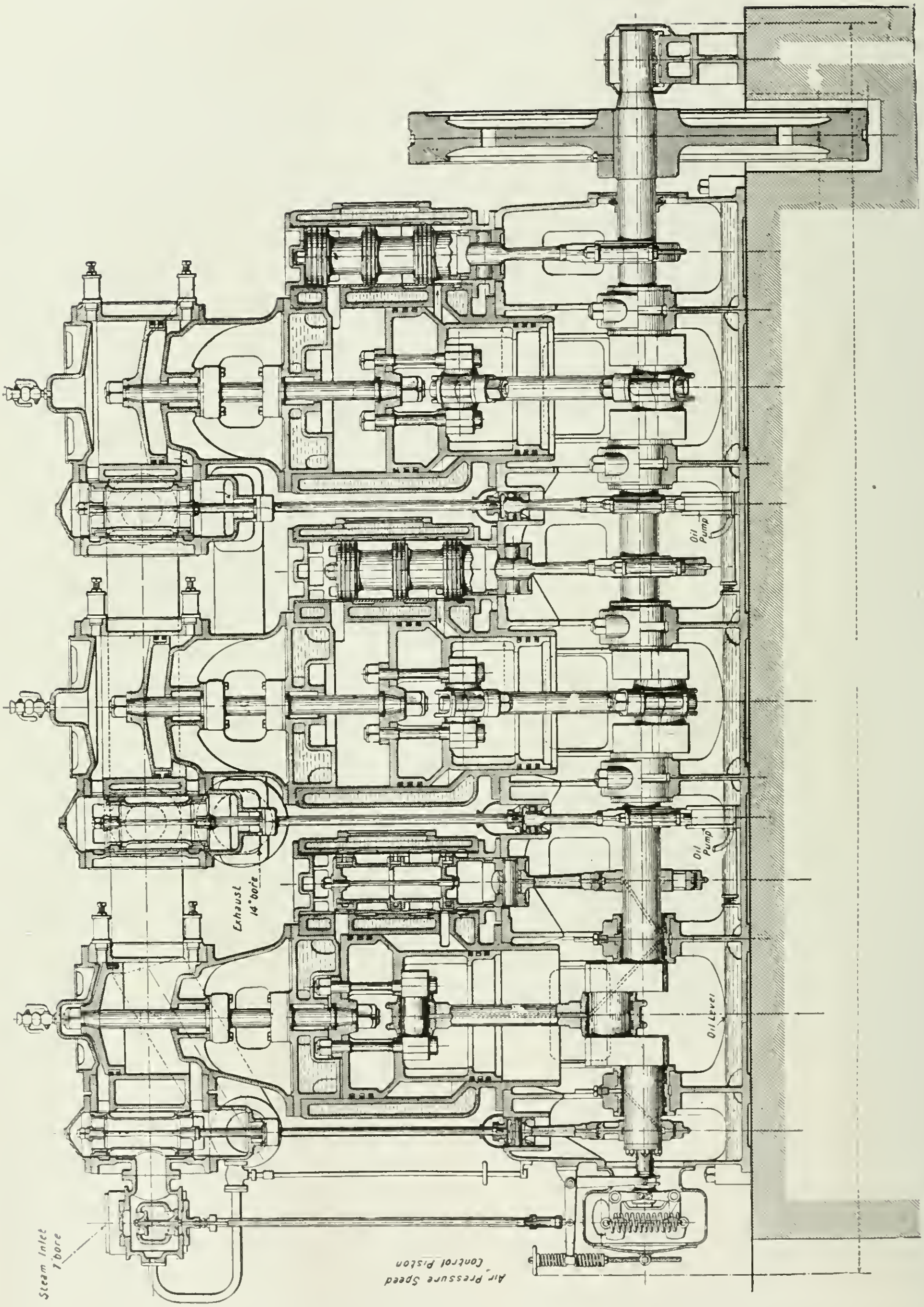

FIG. 11—VERTICAL LONGITUDIANL SECTION OF COMPRESSOR.

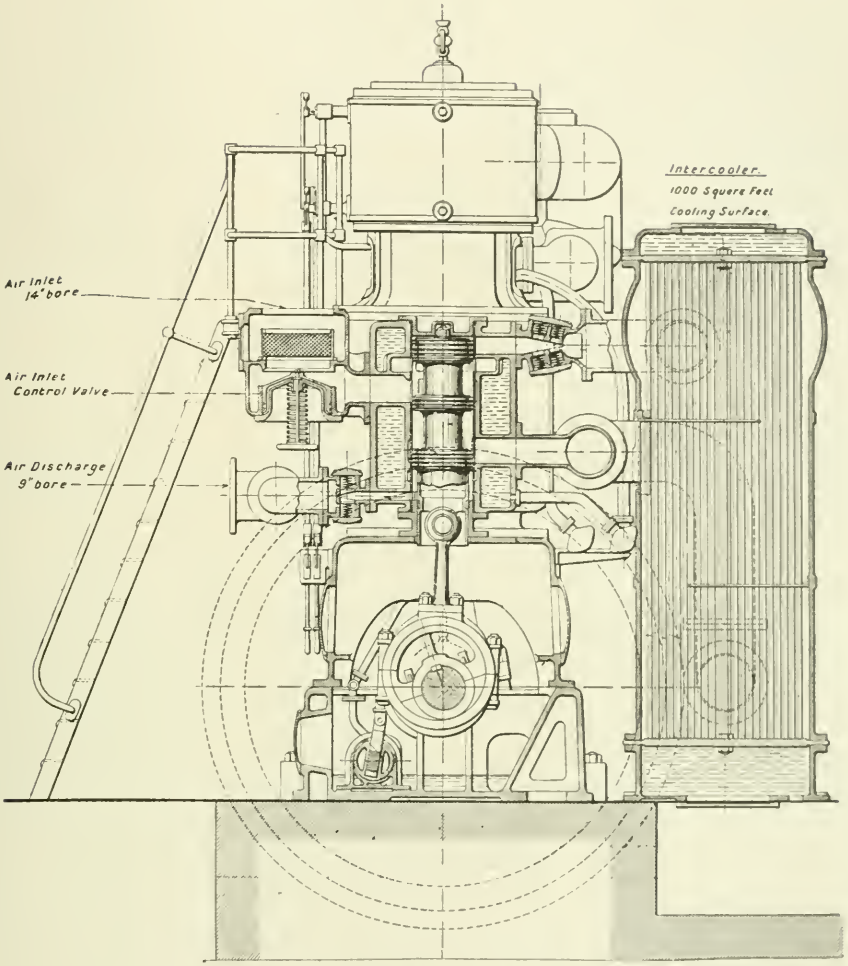

FIG. III—TRANSVERSE SECTION OF COMPRESSOR.

above-mentioned output when supplied with steam at 140 lb. per square inch, and when exhausting into a surface condenser which is capable of maintaining a vacuum within 4in. of the barometric pressure. The designed speed of the engine is 187 revolutions per minute, which means a piston speed of practically 500 ft.

The action of the compressor will be readily understood. During the down-stroke of the piston A, Fig. 2, air from the atmosphere is admitted past the positively operated piston valve D, through the port H to the low-pressure air cylinder B. When the motion of the piston is about to be reversed, the piston valve closes the inlet to the low-pressure cylinder, and when further upward movement has compressed the air the piston valve has moved downwards, permitting the discharge of air over its head and through the low-pressure discharge valve-box to the intercooler. While the piston is thus moving upward, air is drawn from the intercooler past the piston valve into the annular high-pressure cylinder, and the next down-stroke further compresses the air in that cylinder until it is discharged at the working pressure past the piston valve and the discharge valve-box to the storage reservoir. The air is drawn in at the top of the machine, where it is most free from flying grit, and is further purified by passing it through a gauze strainer. The surface area of this strainer is large, and it can be drawn out and cleansed in a few moments.

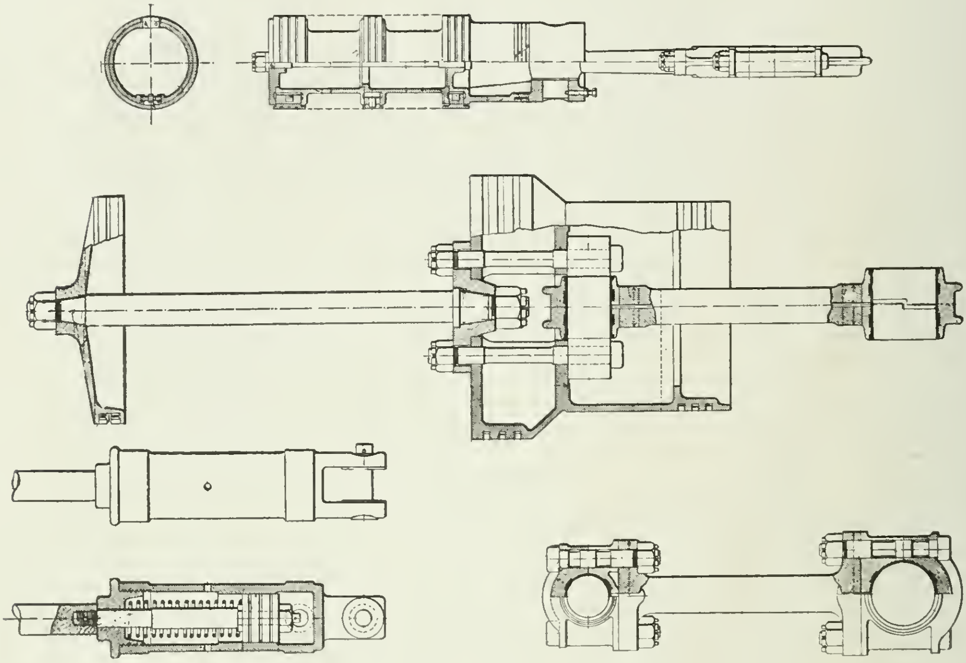

FIG. IV—DETAILS OF COMPRESSOR.

The valve gear is simple and solid. The principal part is the piston valve. This, in effect, is exactly the same as the piston valve of a steam engine, but it is timed somewhat differently. It regulates for both high and low-pressure cylinders—(1) the commencement of admission, (2) the termination of admission, and (3) the cessation of the air discharge. The actual discharge of air from each cylinder is controlled by groups of poppet valves, which are made from special steel oil tempered.

To follow the action, take first the low-pressure end. Imagine that the piston A* has moved enough downward to allow the air in the clearance space to expand to atmospheric pressure. The piston valve D at that moment is far enough up to allow air to be drawn from the atmosphere past the edge of the piston valve marked *a* into the low-pressure cylinder B. At the bottom of the piston's stroke the shuts the port H by its edge marked *a*. Shortly afterwards the piston, having moved upwards, compresses the air until finally, the piston valve having at the same time descended, allows the partially compressed air to escape above its cylinder is full of air, and the piston valve edge *b* through a set of poppet valves, seen in the cross section in Fig. 3, to the intercooler. The functions of the high-pressure cylinder are controlled in the same way, excepting that the motion is opposite.

The piston valves have three other functions in addition to the foregoing: First, they ensure that the poppet valves are returned gently on to their seats. Such valves when placed, as is usual, direct on the cylinder, follow the receding piston, above which they work, on to their seats. In this design the poppet valves follow the piston valve, not the main piston; and, as the area of the piston valve is about one-eighth that of the piston, and as its stroke is about one-fourth, the rate at which the valves come on their seats is relatively as the product of these two, or $^1/_{32}$ of the usual rate. Then, too, the blow the valves strike on their seats is as the square of the rate of closing, so that the valves under consideration strike their seats with $^1/_{1000}$ part of the impact which would result if they acted without the cushion of the piston valve. The result naturally is that there is considerably less noise and that the valves last a good deal longer; indeed, the makers claim that they are practically everlasting, and after continued running show no appreciable wear on their faces. The low-pressure discharge valve is shown in Fig. 6.

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*The reference letters were unfortunately not preserved in the reproduction of the cut.—Ed. C. A.

Secondly, the piston valves reduce the clearance losses to a minimum. The clearance volume is only about 4 per cent. Thirdly, as the makers point out, they introduce the air in thick streams, so that the friction of entry is reduced and the cylinders are fully filled at each stroke with cool air.

After the first stage of compression is complete the air passes through the intercooler, and is there cooled before being delivered to the discharging cylinder. The cold cooling water enters the intercooler at the bottom, flows as it is heated along the lower set of tubes to the other end, and then back along the upper set of tubes to the water outlet. The hot air enters at the top and is discharged when cooled at the bottom. The intercooler works on the counter-current principle, and the air impinges on and is split up by the tubes, so that the cooling surface is utilized to the fullest extent. The circulations of the air and the water are both in the natural directions, so that only heated water and cold air can escape.

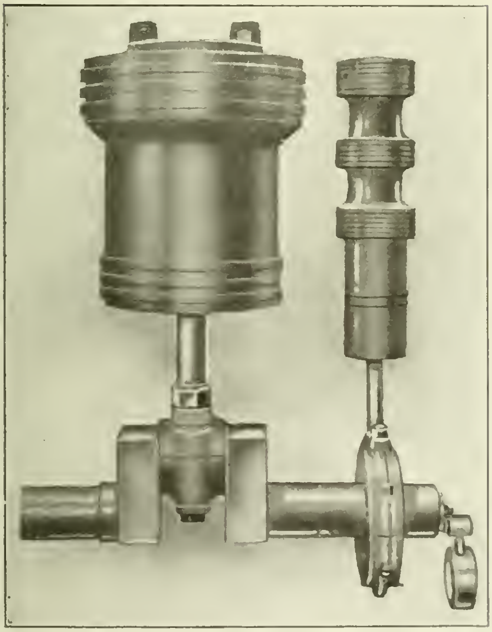


FIG. V—DIFFERENTIAL PISTON AND PISTON VALVE.

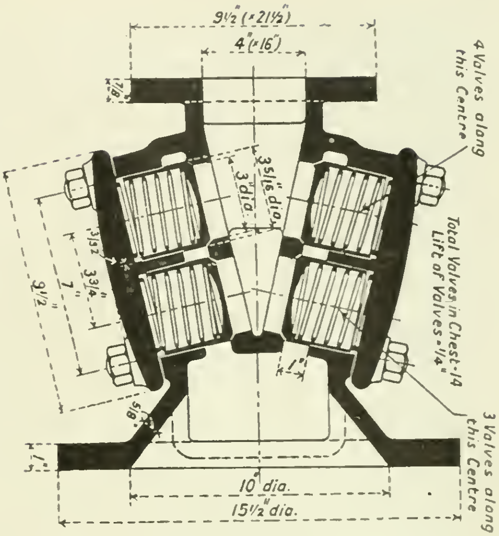


FIG. VI—LOW PRESSURE DISCHARGE VALVES.

The governing of the compressor is carried out automatically. For this purpose an automatic slowing gear has been fitted, which reduces the speed of the plant when the pressure reaches a fixed limit.

The method of oiling is by forced lubrication. Two valveless oil pumps are provided, and these are operated from the low-pressure steam valve eccentrics. They are disposed 120 deg. apart, so that there is a fairly uniform distribution of oil into the lubricating pipe system.

The net shipping weight of the compressor was 60 gross tons, and of the condensing plant 7 tons.

Consul Ralph J. Totten writes from Puerto Plata that there are very few windmills used in Santo Domingo. If Spanish-speaking salesmen could be sent to demonstrate the utility of the windmill in connection with agriculture and stock raising, a demand could be created. Many portions of this country, naturally fertile, suffer from lack of moisture in the dry season. This difficulty could be overcome by windmill and tank irrigation.

COMPRESSION AND TRANSMISSION OF NATURAL GAS

Natural gas as it occurs in the States of the Middle West often emerges at pressures considerably above atmospheric; sometimes several hundred pounds higher. In some cases, however, the pressures are so low as to be insufficient to drive it through by transmission lines except with prohibitive size and cost of pipe. In such cases compressors are employed to increase the pressure and reduce the volume of the gas. These compressing units are of large size and quite naturally the gas itself, in suitable gas engines, is being adopted as the handiest and far the cheapest source of power.

The practical limit for transmission pressures is about 350 pounds, as higher pressures, especially in cold weather cause liquid and even solid deposits of constituents of the gas, and even at pressures considerably lower drainage tanks must be provided along the line.

An interesting plant for this service, which we here illustrate, is that of the Mohican Gas and Oil Company at Howard, Ohio. The gas which is here pushed along comes from a hundred gas wells located within a radius of 35 miles, the pipes leading to the station being from 6 to 10 inches in diameter. The combined supply of gas after compression is transmitted through 16, 12 and 10-inch pipes, reaching as far as 80 miles to Akron, Barberton, Orrville, Millersburg, Wooster and intermediate towns.

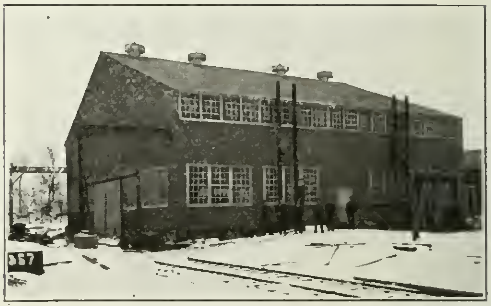


FIG. I—COMPRESSOR HOUSE.

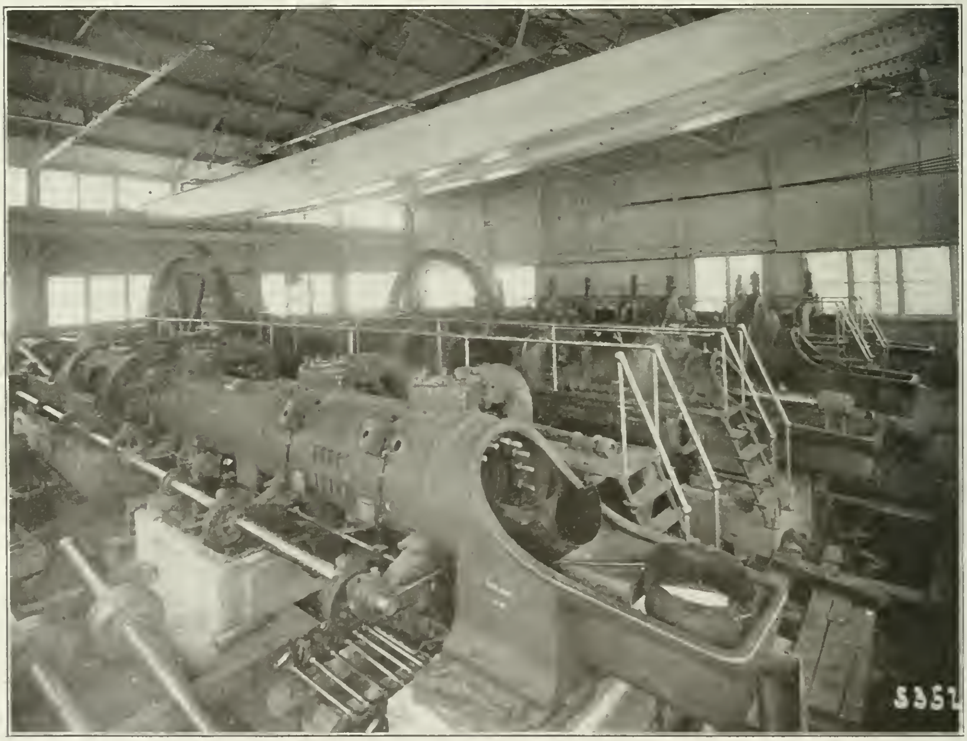


FIG. II—GAS ENGINE END OF COMPRESSOR.

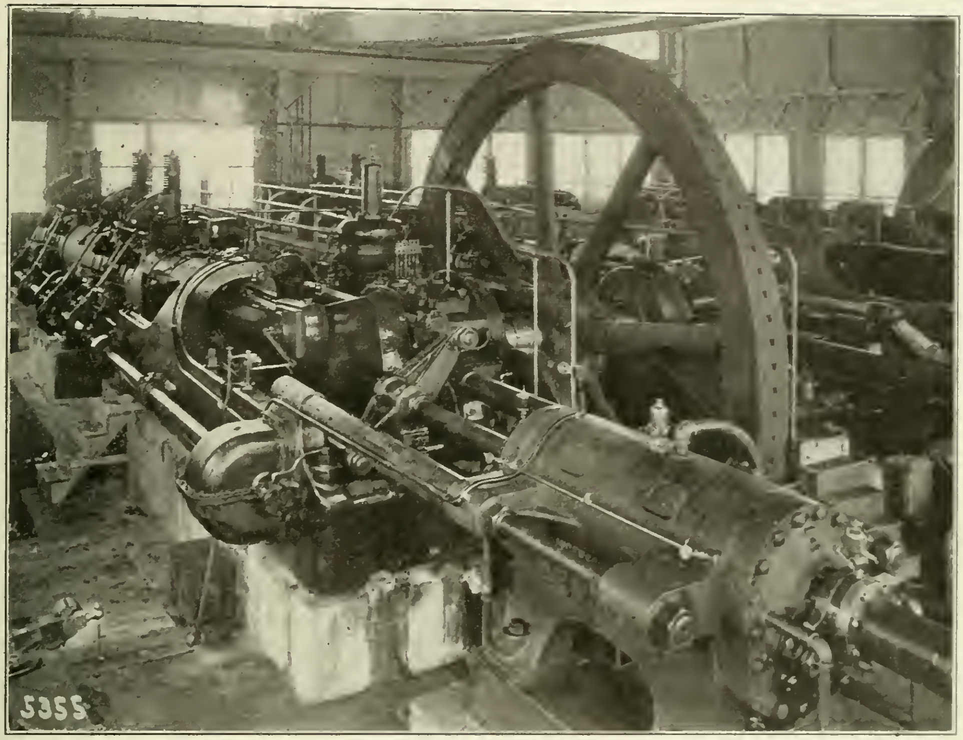


FIG III—COMPSESSOR END.

There are two compressors at this station, both of them gas engines of the Westinghouse horizontal, double-acting, four-cylinder, four-cycle type, giving one impulse in each end of each cylinder every alternate revolution, or four impulses per revolution, the same as with a two cylinder steam engine. Ingersoll Rand, Piston Inlet cylinders comprise the compressing feature of the machines.

Fig. 1 is a view of the outside of the compressor house, chiefly notable for the absence of boilers and stacks and piles of fuel. Fig. 2 shows in the foreground the gas engine end of one of the compressors with the assembling not completed, the fly wheel of the compressor in the background showing it to be running at full speed. The engine cylinders are 23½ in. dia. by 48 in. stroke, giving at the maximum speed of 88 revolutions per minute about 1300 brake horse-power.

Fig. 3 shows the completed compressor end of the other machine. The compressing cylinders are 18 5-8 in. dia., the two cylinders at the above speed giving a piston displacement of 2410 cu. ft. per min. The piston inlet here shows its special adaptability to this line of service, the gas being piped direct through the hollow piston rod into the piston itself and then passing the piston inlet valve into the cylinder. The piston inlet valves in these machines are of the improved or "Hurricane" type. The valve is a single ring of large diameter with a T section, the top or flat of the T seating against the flat face of the piston and closing an open annular groove near the periphery of the piston No mechanism and no springs are required to operate the valve, it seating itself by its own inertia when the piston starts upon its compressing stroke and opening also by its own inertia to full lift when the return or intake stroke begins When the valve is open the gas is free to flow into the cylinder at either the inner or the outer edge of the valve thus largely increasing the freedom of inflow. The discharge valves in the compressing cylinders are of the ordinary poppet type with springs, and when they are thrown open the trapping of a small portion of gas in a pocket of the cap cushions the valve and prevents actual striking. The cylinders are of course water jacketed.

After the compression the gas is passed through a system of piping entirely submerged in water, both to cool the gas and to precipitate the moisture and as much as possible of the liquid and solid deposits of the gas before passing into the long pipe lines.

In connection with the main compressors there is an auxiliary service actuated by two 45 horse power three-cylinder Westinghouse vertical gas engines driving electric generators and centrifugal pumps, the electric current for lighting and also for gas ignition in the cylinders and the water for circulating in the jackets. The auxiliary engines also drive small air compressors compressing air to about 175 pounds which is stored in receivers and used for starting the main engines.

MINES, MINING AND MINING INVESTMENTS

Readers of the COMPRESSED AIR MAGAZINE are interested in all phases of mining. The following is condensed from an admirable article by Richard Linthicum in a recent issue of *The Evening Post,* New York.

Although the prospector rarely receives a large reward for the discoveries he makes, he is the architect of many large fortunes for others. The successful mining camps are his monuments. The thousands of deserted cabins on the mountainsides are the mute records of his blasted hopes. His days of profligate glory vanished when he learned, as a result of the investigations of mining engineers and geologists, that the surface gold deposits of the United States were practically exhausted. Thenceforth the fortunes from successful mining were to come from the depths of the earth, and could only be gained through the work of scientific men and large investments of capital.

Not one in a thousand of present-day prospectors can profit from the discoveries he may make without the assistance of capital, and the capitalist can rarely see anything but a large round hole in the fattest mining-camp doughnut. Nevertheless, the prospector is as necessary to the mining industry now as in the happy-go-lucky days of the past, and although his chances of finding mineral in paying quantities are growing less from year to year, he is the same enthusiastic capitalist in embryo.

HOW MINES ARE DISCOVERED.

The history of mining contains many authentic accounts of the accidental discoveries of rich mines: A mail-carrier between two mining camps, while descending a mountain loses his footing; to save himself, he grasps a projecting rock, tearing it loose and exposing a vein of mineral; a miner pursued by a bear runs across a mineral ledge; the prospector's burro paws in the snow for food, overturns a stone, and behold! there is virgin gold. Discoveries of the sort described are the exceptions and not the rule. Perhaps some of them are not true.

To assume that Chance and Luck are the chief factors in the discovery of mines is a reflection upon the intelligence and the industrious efforts of the simon-pure prospector. He is more or less familiar with the forms in which mineral occurs. He can tell pyrites of iron from gold, but knows that the two minerals are frequently found in combination; he knows the common forms of lead, zinc, and copper, and the natural matrices—silica and lime—for precious and base metals. But, most important of all, he knows the prevailing eruptive rocks of the locality, especially the many forms of porphyry, and he knows, when he finds eruptive rocks on the surface, that mineral is to be found thereabouts.

Hence, when the late spring comes and the snows melt and he goes on a prospecting trip, he searches among the eruptive rocks on the surface for pieces of mineralized rock, commonly called "float." Once he has found "float" on the mountainside, he is then on the trail of the mineral, so to speak, and his next step is to trace it to its source. This is not always an easy task, for the "float" may have been detached from the main body many years before and the original source have been covered by "wash"—earth, gravel, and sedimentary debris. It often happens, however, that the "float" is from a mineral ledge, jutting out of the ground, or from a body of mineral plainly to be seen on the surface—the cropping of the vein or deposit.

MAKING A "LOCATION."

When the prospector has found a vein or deposit, either by tracing the float rock or by observing mineral stains on a partly eroded cliff, his next task is to determine as well as may be whether it has any value. Having satisfied himself by whatever means concerning the value of the ore, he locates his claim, the dimensions varying in different States, but usually 300x1,500 feet, and begins to prospect it either by driving a tunnel or sinking a shaft, according to the topography of the country.

A tunnel is cheaper and less laborious than a shaft, for the latter requires a windless and much time and work to raise the broken material to the surface. If the tunnel be a "crosscut"—that is, a tunnel to intersect the mineral body at an angle—and must be driven through the country rock, the work of drilling and "breaking ground" can be done much more cheaply and more expeditiously than by the sinking of a shaft vertically through the same kind of rock.

CO-OPERATION OF CAPITAL NECESSARY.

Except in unusual instances, the prospector is no better off after he has discovered and located his "claim" and proved the existence of mineral than he was prior to the discovery, unless he can get the co-operation of capital or sell the property. When the ore is a kind that requires milling, either for the purpose of concentration or separation, the development of ore reserves becomes an absolute necessity for safe operations. Ore that requires treatment in a mill, whatever net profit it may yield as a result of proper concentration or separation, is as valueless to the prospector as the prevailing country rock, so far as his individual operation of the mine is concerned. In other words, a "mine," unless it is one of those exceptions which furnish ore of extraordinary value, is not a mine until it has been systematically developed and sufficient tonnage put in sight to insure regular shipments, or the operation of a milling plant for a period of time at a profit.

This means that before ore can be mined properly and profitably in the average mine there shall be capital outlay for development work. This is a fact and a condition not known or not understood by many men who invest in mining enterprises.

It is more or less apparent therefore that to develop a mine and at the same time insure the safety of the workings, operations are conducted, and perforce must be, with approximately geometrical precision. The size of a block of ore varies with the character of the vein and the wishes of the mine manager, but is usually one hundred feet in length and height.

As an illustration, let it be assumed that the ore is in a vertical fissure vein—not a perpendicular vein, for most verticals have a decided incline, or "dip"—and that the prospect work consists of a tunnel driven upon the vein for 200 or 300 feet. The ore encountered on the tunnel is taken out, of course, as the tunnel is driven, but the ore above and below the tunnel level and beyond the breast of the tunnel remains unexplored. As the dimensions of a tunnel are usually four by six feet, the amount of ore extracted in this exploratory work depends upon the size of the vein, but in no event is it a considerable quantity. The ore above the tunnel level may be developed by putting up "raises" 100 feet apart, and the ore below may be developed by putting down "winzes" 100 feet apart and to a depth of 100 feet, and then connecting them by another tunnel, or technically a "level."

If the discovery tunnel were near the surface, and topographical conditions did not permit lower tunnels to be driven, a prospect of the sort described would be developed by sinking a shaft from the surface, and running "levels" or "drifts" upon the vein every hundred feet, connected by "raises."

READY FOR "STOPING."

Then the various blocks of ore are ready for "stoping," which is the actual mining of the ore. In "stoping," or breaking down the ore, the miner is always beneath the ore body. The method of "stoping" depends upon the character of the ore. The soft oxides and carbonates frequently can be stoped with a pick. The sulphides are broken down by drilling and blasting. As the ore is broken down, the "muckers" load it into mine cars, and the "trammers" push the cars out of the tunnel or to the shaft.

The size of a "stope" varies with the size of the ore body. It may be as large as an ordinary room, or simply large enough to enable the miners to do their work.

Methods of operating mines vary in details according to topography, the character of the "ground," that is to say, the formation, whether it be hard or soft, and the physical characteristics of the ore deposits. For a number of years there has been constant progress in mining methods, which has resulted in great economies. The original method of developing and operating a mine was through a working shaft—the most expensive of all methods, necessitating a large outlay for machinery and power, not only to hoist the ore, but to pump water out and air into the mine. The large costs of shaft operation have been reduced in many cases by the substitution of electrical power for steam, but the outlay for machinery remains the same. The method of shaft operation is rapidly falling into disuse in all localities where topographical conditions do not make it necessary.

MODERN ECONOMICAL METHODS.

The modern economical method of mine operation is to drive a large tunnel—a main working adit—to intersect the vein or veins at an angle and at as great depth as possible, and then operate the ground above the tunnel level. By this method gravity does the work of steam and electricity, and dispenses with much costly machinery. The ore and waste are dropped down to the main adit level, and the former, if the tunnel be properly located, conveyed to a loading platform or to a mill, as required, by a gravity tram.

Not only is the cost of operation reduced to a minimum by this method, but there is also a large saving in original cost of development work, as a tunnel can be driven for one-half the amount required to sink a shaft under the same conditions.

Much thought is given at the present time by mine operators and mining engineers to the problem of economy in timbers. Most mines require timbers, which are a considerable item of expense on account of the necessity of frequently renewing them. I was recently in a group of mines where there were thirty miles of underground workings, a greater portion of which required timber. For purposes of ventilation it was necessary to keep a large part of the workings open, and the timbers were renewed practically every two years.

LOW GRADE VS. HIGH GRADE.

The numerous recent economies in mine operations, together with the improvements in mining tools and machinery and advances in metallurgical science, have made it possible to operate mining properties successfully, which were practically worthless a few years ago. This is particularly true of mines carrying base metals, copper, lead, and zinc. The tendency of mining to-day is all toward the development and operation of base metal properties, because the base metals are found in large quantities and are comparatively permanent in character. In the mining of base metals the percentage of risk is materially reduced as compared with precious metal mining, especially gold properties, by reason of the size and persistency of the base deposits. The most precarious mining is for gold exclusively, and the risk is proportionate, approximately, to the richness of the ore. The "gold mine," however, is the greatest attraction for the investor. Experience shows that the surest and safest mining is in the development and operation of the large deposits of the baser metals reduced practically to a manufacturing enterpirse by economy in mining, handling, and treatment.

Not all gold mines are "bonanza." The largest and most permanent producing gold mines are those in which the ores are of low value, existing in large quantities. The ore in the largest two gold mines in the United States does not average more than $3.50 per ton. Through economies in mining and milling, these properties pay large dividends annually, while hundreds of bonanza gold mines fail comparatively or utterly.

The development and operation of low grade deposits of base minerals have been retarded many years by the presence of zinc blended with the other minerals. Until five or six years ago, zinc was the bane of metaliferous miners. At present it is one of the most sought for minerals, for the reason that advances in metallurgy have made it possible to separate it from the accompanying minerals and thus permit of its separate treatment in smelters.

If investors in mines would take the pains to inform themselves about the most elementary facts concerning the mining and treatment of ores, the nature of the deposits and the methods of extraction, the disasters and losses in mining ventures would be greatly reduced.

THE FIRST COAL CUTTER IN BENGAL

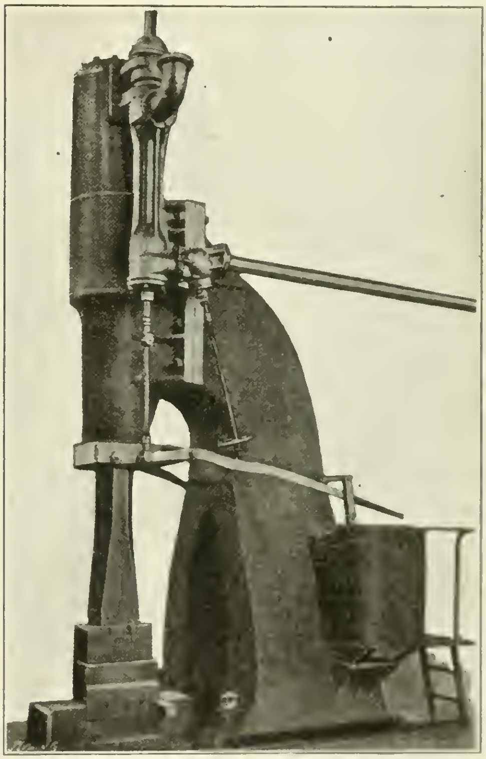
In a paper printed in the Transactions of the Mining and Geological Institute of India, Willis Howarth gives an account of the working of a colliery of the Secteramore Coal Company, Nursamooda, India.

The management decided to try mechanical coal-cutters, so that the output would be steadier and not so spasmodic as is the case when native labour is employed. A compressed air plant has been put down at No. 3 pit for generating power to run one machine and the pumps. The steam cylinders are 24 in. in diameter with 24-in. air cylinders, and were supplied by Messrs. Walker Bros., Wigan. The plant will only be single for a time, but the duplication can be brought out any time it may be thought necessary. The receiver at the surface is a 30 by 7 ft. Lancashire boiler, and the air is being carried down the shaft in 6-in. pipes, specially made with patent packing for the joints. The receiver underground is an 11-ft. cylinder 3 ft. 6 in. in diameter. It is placed near to the face, and from it the air is led by 2-in. pipes to the coal-cutter, which requires about 700 cubic feet per minute at 45 lbs. pressure.

The cutter was supplied by the Diamond Coal-cutter Company, Limited, Wakefield, this machine being the first of its kind in Bengal; cylinders 8 in., stroke 8½ in., cutting 5 ft. 6 in. under the coal. With this machine it is expected that the output will be increased by 4,000 tons monthly in No. 3 pit. On the duplication of this plant it is estimated to generate 3,500 cubic feet of free air per minute, at a pressure of 60 lbs. at the receiver, sufficient to work four cutters.

A STEAM HAMMER CONVERTED TO AIR

The half-tone here reproduced from *The Engineer*, London, shows a steam hammer belonging to a well known firm of British shipbuilders which has recently been altered to enable it to work with compressed air instead of steam. The stand for the operator indicates that the hammer is not a small one. The weight of the falling parts is 5,500 and the limit of stroke is 42 inches. There are operating levers on both sides of the hammer. The change from steam to air necessitated the attaching of compound air cylinders, complete with tup, valve chest and operating gear, to the existing steam hammer standard without alteration of base plate or anvil block. There are two cylinders one above the other, the lower serving as a guide. The upper end of the tup, working in the top cylinder has the function of a differential piston. High pressure air raises the tup, and this air on being exhausted is expanded on the top side of the piston, giving sufficient force for ordinary blows. If a very heavy or stamping blow is required the operator can apply the full air pressure on the top of the piston, the re-expanded air serving as part of the charge and the augmented pressure being made up from the air supply. In regular running, owing to the difference in the areas of the annular ring below and of the entire piston surface above, the air first used to raise the tup is expanded to nearly four times its initial volume and is finally expelled at about atmospheric pressure by the raising of the tup again.



LARGE STEAM HAMMER CONVERTED TO AIR.

AIR DESTROYS WOOD

Piles driven by the hut dwellers of the Baltic, centuries ago, are as sound to-day as when first placed. The wooden coffins in which the Egyptians buried their dead are still preserved in perfect condition, after thousands of years of service.

The longevity of timber under these two extremes of climate and moisture conditions has naturally made people ask, what causes wood decay? The answer is, fungi and bacteria—low forms of plant life which live in the wood and draw their nourishment from it. The little organisms are so small that a microscope is required to see them, yet their work results in the destruction of billions of feet of timber each year.

In stuyding the means of preventing decay wood-preserving experts have learned many things about the obnoxious fungi which sap the life of timber. The small organisms can grow either in light or in total darkness; but all of them require requisite amounts of air, food, moisture and heat. If one or more of these essential requirements is lacking, they cannot live, and the decay of timber will not take place. Wood constantly submerged in water never rots, simply because there is an insufficient supply of air. This condition accounts for the soundness of the old Baltic piles. On the other hand, if wood can be kept air-dry it will not decay, because there will then be too little moisture. The timber used by the Egyptians will last indefinitely so long as it is bone-dry.

There are a great many cases, however, where it is impossible to keep wood submerged in water, or in an absolutely air-dry condition. In fact, a large percentage of the timber used is exposed to the weather, and is subjected to decay simply because it contains enough air and enough water for the decomposing organisms to get a foothold. Decay is most serious where the atmosphere is warm and damp, because these conditions are most favorable for its development. In the coal mines of Pennsylvania timber decays in two or three years, because the temperature is warm and constant and the air is damp; and in the south the warm, humid atmosphere often causes the timber to rapidly decompose.

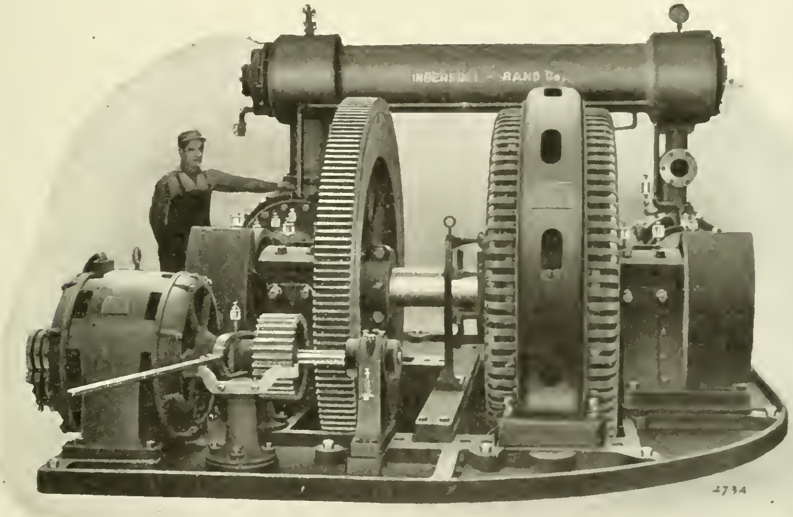
Decay may be prevented by two general methods, by treating the wood with antiseptics, thus poisoning the food supply of the organisms which cause decay, and by treating it with oils, which render it waterproof. A combination of these two methods is most commonly used, as, for instance, when wood is treated with creosote, which fills up the pores and keeps out water, and is also a powerful antiseptic.—*Government Bulletin.*

COMPRESSED AIR PUMPS SEWAGE

Pumping of sewage is required in many cities, either for the entire service or for sections which lie lower than any possible outlet which would permit flow by gravity. In many cities also which discharge into large rivers the occurrence of freshets makes pumping necessary. All the familiar devices for raising water are employed, the choice being determined by various circumstances. The Municipal Journal and Engineer has recently given a brief sketch of the sewage pumping arrangements of some thirty cities from New England to the Pacific Coast.

Centrifugal pumps seem to be the favorite, then plunger pumps, and compressed air also has employment. Newark, N. J., for a part of its sewage system is constructing a small pumping station, with a capacity of 500,000 gallons per day, which is to be operated by compressed air.

The Plainfield, N. J., pumping outfit consists of two 10x6 Ingersoll-Rand Class E, air compressors; two 7½-horsepower Wagner motors, equipped with Cutler-Hammer automatic stopping and starting device with a float switch which operates to start and stop the compressor according to the level of the sewage in the stand pipe; one Fairbanks gasoline engine for operating the compressor in case of failure of the electric current; a 42-inch by 8-foot air receiver, and two Duplex displacement pumps or ejectors constructed by the Latta & Martin Pump Company, of Hickory, N. C., operated by air supplied by the air compressors to the air receiver. One-half of the plant is operated at a time, and when so used it has a capacity of 277 gallons per minute. The pumps are placed in a concrete well 13 feet in diameter; the cylinders composing the pumps being entirely below the level of the sewer, and the air being shifted from one pump to the other by means of buckets within the cylinders, operating by the difference in weight of the bucket in the empty cylinder and that in the full one, these buckets operating a sort of walking beam which, in turn, operates the valve cylinders. Pipes and valves are provided for blowing the sewage from either pair of cylinders back into the sewer when it is desired to open the cylinders for examination or repair. The sewage is pumped through a force main 2,500 feet long, against a static head of 15 feet and a dynamic head of about 20 feet. The plant is visited twice a day and operates automatically without attention during the remainder of the time.



WESTINGHOUSE SYNCHRONOUS MOTOR DRIVING INGERSOLL-SERGEANT AIR COMPRESSOR EQUIPPED WITH AUXILIARY SLIP-RING INDUCTION STARTING MOTOR.

THE SYNCHRONOUS MOTOR FOR AIR COMPRESSORS

The slip-ring induction motor is used where frequent starting and high starting torque are required. It lends itself particularly well for elevators and hoists and also for pumps and air compressors if automatic starting and stopping control are required.

The synchronous motor is often used on large units where infrequent starting and high power factor are wanted. There are many power companies which strongly advocate the use of synchronous motors wherever possible, so as not to further reduce the power factor of their existing line and in many cases to improve the existing power factor. Owing to the almost uniform character of the load of an air compressor, this machine lends itself especially well for the use of synchronous motors when placed on electric lines for the purpose of raising their power factor.

An instance of this is at Dos Estrellas mines of El Oro Mining and Development Company, in Mexico. Here there are two 200-horsepower direct-connected air compressors with synchronous motors operating on the Necaxa power line. The synchronous motors on these units are started by an auxiliary 50-horsepower slip-ring induction motor, by means of sliding gears. The half tone illustrates one of these units. Another instance of this is in the United States navy yard, at Norfolk, Va., where there are two 550-horsepower direct connected air compressors with synchronous motors of the self starting type, being installed. In both these instance, the synchronous motors are being used directly to improve the power factor of the existing power lines and thus increase the capacity of the generating station and the transmitting wires.—*S. B. Redfield in American Machinist.*

Of widespread interest, especially to American manufacturers, is the announcement that in future Japan will admit all foreign mining machinery free of duty.

PORTABLE OXYGEN IN A MINE RESCUE*

By Dr. James Robertson.

Pretoria Pit, situated about one mile from Clackmannan, is worked in two seams—an upper seam, 35 fathoms deep, and a lower seam, 40 fathoms. The gradient is 1 in 5. The pit is surrounded on all sides by old workings, containing water and foul air. Three-quarters of a mile to the west of the pit is a large unused quarry, covering several acres of ground, and about 40 ft. deep, full of water; an old pit shaft opens into this quarry. The water suddenly broke into the lower seam. After the flooding was complete the whole amount of air in the lower seam would be about 20,000 cubic feet, coming from all the various passages and openings of every description. All the men except five escaped. Three of these were in the rise of one road, two were locked up in another. The three had about 70 yards of road to creep about in. The two were locked up in a space 2 ft. 6 in. high, 3 ft. broad, and 18 in. from tail of water to coal face. They were sitting with their backs against the coal face and their feet in the water. The men were discovered in the usual way. They scored the roof with a stone, and the sound was heard by the search party in the upper seam. After ten hours' working with pumps it was found impossible to gain on the water, and it was decided to sink a dumb shaft from the upper to the lower seam, near the point where the men were heard knocking. Before starting the dumb shaft, a 3 in. borehole was rapidly put down, when it was discovered that there were only three men here—a father and two sons. Another search was made, when the other two men were located—a father and son. The three men were fed and kept supplied with candles through the borehole until rescued. The pit chart showed the other two men to be in such a perilous position that nothing could be done from the upper seam to save them.

When the pit was suddenly flooded, on February 3, 1906, at about 9.30 a. m., the section where the men were entombed was completely isolated by water, and they were left in an island of air, which was compressed by the sudden roofing of the water. This section was a main road with several side roads leading from it, the average height being about 2 ft. 9 in., the breadth about 5 ft., and the length about 70 yards. The contained air of this main road and the side roads was estimated at 20,000 cubic feet. The five men were breathing this air for four days, three of them also having a light burning, and thus causing an alteration of the compotent parts of the air, diminishing the oxygen and increasing the percentage of CO_2. The other two men were in darkness. On February 6, at 8 p. m., when the sinking of the dumb shaft was completed, the compression was relieved, and exhalation at once began until air equilibrium was established. This exhalation of air diminished the amount of air in the lower seam. After the three men were removed, twenty men now went down the shaft, and proceeded to effect communication with the remaining two men still entombed. In about three hours a stage was reached at which lights would not burn, and breathing was only possible with difficulty; work had to be suspended, and the rescuers were left in darkness. An interesting question here arises: (1) What is the lowest percentage of oxygen compatible with conscious life? (2) What percentage of CO_2 gas may be mixed with air and yet conscious life be supported, and for how long?

At this stage, which was midnight February 6-7, about 40 cubic feet of oxygen was liberated at a point about 150 yards from the dumb shaft, and several feet from the two imprisoned men. This so altered the air conditions that lights were got to burn, breathing became easy, and work, which had been suspended, again commenced. The oxygen supply was kept up as required until 4 a. m., when we all arrived at the upper seam.

During February 4, 5, and 6, while the dumb shaft was being sunk, and before the complete penetration of the rock strata, the air was confined and compressed between the tail of the water in the various roads on the one side and the coal face on the other. The tail of water was a movable, the coal face a fixed, quantity. The water chests, proceeding up and down the shafts, impinging against the water in the shaft before filling, and lifting each time about 1 ton of water to the surface, set up a movement along the water throughout the pit, thereby causing for each impingement a tidal move at the tail; this tidal movement communicated itself to the confined air at various points surrounding the places of entombment, and thereby kept the air in motion, causing a continuous mixing and aiding ordinary physical diffusion, thus preventstagnation of CO_2 gas produced by the breathing and lights.

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*From a paper before the Stirling branch of the British Medical Association.

On the evening of February 6, when the shaft was sunk, compression was relieved, exhalation took place, and, although chesting was continued, the movements now communicated from the water to the air became less effective, as all air movement at once tended towards the point of least resistance—the dumb shaft. It follows (1) that as the dumb shaft was a funnel from the lower the twenty rescuers in the lower seam were consuming and burning the air oxygen, and seam to the upper, and the only opening, no air could be sent down that shaft; (2) that ly two miles, so that it can be dredged and liberating CO_2 gas at a point about 150 yards away from the dumb shaft. The CO_2 gas rapidly increased, and any movement communicated from the water to the air simply mixed a highly poisoned air with a less poisoned air, as no fresh air could gain entrance; during this time also the water level was lowering, and there is no doubt that CO_2 gas, or blackdamp, was creeping on us from some old workings. At this stage, when lights went out owing to CO_2 gas, it mattered little whether water chests impinged on water or not, as all the confined air was highly charged with CO_2 gas, and all air movement was towards the dumb shaft.

The only thing now was to liberate oxygen as near as possible to the imprisoned men; a displacement of gases followed, and a diffusion of oxygen through the poisonous air; the oxygen effect beginning at the point of liberation, and gradually working its way backwards to the dumb shaft. This is what I expected, and what happened. During this final stage the rescuers were in an atmosphere CO_2 gas in which no lights would burn for about fifteen minutes.

PROOF OF OXYGEN TRAVEL.

When proceeding down with the oxygen from the dumb shaft, the first few yards of our journey lights burned; as we went in they gradually lessened, and finally went out; about 80 yards in we passed some of the rescue party scattered and sitting in darkness; we proceeded about 60 yards in advance of them, and then gradually liberated the oxygen. The lights were soon set burning at the point of liberation, and some time afterwards the party of men we passed also got their lights to burn; and in both places lights burned until we all arrived safely at the upper seam.

Here let me add that acetylene gas will burn in a percentage of CO_2 gas with air in which an oil wick light will not. Whether this fact has been proved by former experiments or not, I cannot say, but it was so in this case.

On the afternoon of February 7 I again went down the pit, and found the air in the lower seam so foul and charged with CO_2 gas that no light would burn, even in the dumb shaft, and descent was impossible. On February 10 the water was reduced to the level of the roads, thereby allowing an air current which cleared away the island of CO_2 gas, and I traveled over that section of the pit with safety and with lights.

These facts prove also my statement that no air could have entered the section where the rescue party were working unless a borehole or other opening had been made as stated.

They also show the dangers we all passed through, and establish for all time the value of oxygen in all such cases. Had oxygen not been used, the two men would have lost their lives.

A German patent has been taken out for a linoleum substitute. A fatty oil is heated for a short time and is then vulcanized by treatment with a molten mixture of resin and sulphur, air being blown into the mass during the operation. The vulcanized oil, before it sets, is then distributed in a fine state of division over the fabric which is to form the foundation of the material. If a specially hard material is desired, small quantities of a vulcanizing agent, capable of being spread or finely divided, e.g., sulphur chloride, are mixed with the vulcanized oil as it is being distributed over the fabric, and the material is subsequently passed between heated rollers.

THE PANAMA CANAL

A correspondent of *Engineering-Contracting*, Mr. Warren Wood, writes as follows:

I will give a brief description of the canal as I saw it and as truthful as I can remember: Around Colon every where are to be seen the activities of the Americans, but no great problems are to be solved here. Coming to the Gatun Dam, this bone of contention, such as underground lake, 500 ft. of mud, stratified rock, etc.; this great fill which is going to make the dam is going to be so large and contain so much material that its very weight will be the means of suffocating the underground lake, squeezing the mud out of existence, holding down the stratified rock, and make every liar that has seen "the dam going out into the sea" sneak into his hole and pull the hole in after him.

The great dam will be about a mile long, a half-mile wide at the bottom and about an eighth mile wide at the top; a young mountain thrown into a valley that the Chagres River will never move. When the dam is finished, and the waters of the Chagres River are held back there will be no sudden rise of the river as there is now, caused by the heavy rains and creating a terrible force of water. After the dam is finished it will be like pouring water into an immense tub and letting it run out of the other side over the spillway and thereby losing its force. When this artificial lake is formed it will reach to Bas Obispo, and from there starts the Herculean feat of cutting through a mountain, Gold Hill being the highest cut, from the bed of the canal to the top it being nearly 900 ft. From Bas Obispo to Paraiso is the greatest excavating, the rock is of such a nature in a great many places that it requires drilling and blasting, but the largest amount is taken out by the Giant steam shovels, as, with but two or three exceptions, the whole Isthmus is volcanic ash, compressed and of such a nature that it breaks and slides.

The average person's conception of the canal is a cut through the mountain, like a canyon of the West, but in reality it is a ditch at an angle so sloping that the earth cannot of its own weight slide toward the center. Standing on the top, at Empire, it seems almost impossible that human beings ever dug through such a mountain. On the Pacific side, walls have practically been extended to an island for nearmade deep enough without its filling in from the action of the waters. The same length and height of locks is required on the Pacific side as on the Atlantic. The rock for the Gatun dam is taken from Porto Bello, eighteen miles down the coast from Colon, and is as fine a quality as the Staten Island or Princeton trap rock and will withstand the elements for a thousand years.

I will predict that Panama City and along the canal from Bas Obispo to Paraiso will be the favorite summer resort for thousands of Americans during February and March after the canal is finished. In conclusion, I will say the canal is being put through by the best methods, and by as skilled and competent a lot of men as was ever my good fortune to meet. Their hospitality and kindness to a stranger in a strange land will never be forgotten.

GLOSSARY OF AVIATION

The following list of words is proposed by *Patent Progress*.

Aviation—The science or art of flying.

Avio—A non-gas-using air vehicle.

Aviator—The driver of an avio.

Aerostat—A free balloon without propulsive power.

Aeronaut—A balloon having propulsive power, commonly called a "dirigible balloon."

Aerodrome—The enclosure in or from which ascensions or flights are made.

Aeronaut—One who navigates the air.

Aerocurve—(Usually called aeroplane). A thin substantially horizontal, substantially immovable surface which supports the avio as it is propelled through the air.

Monoplane—An avio with but one horizontal aerocurve.

Biplane—An avio with but two horizontal aerocurves.

Polyplane—An avio with a plurality of aerocurves, usually more than two.

Helicopter—An avio which is raised and supported in the air by substantially horizontal rotating screws.

Orthopter—An avio with wings that flap as do those of a bird, dragon-fly or beetle.

Stateoscope—A delicate instrument which indicates whether a balloon is rising or falling.

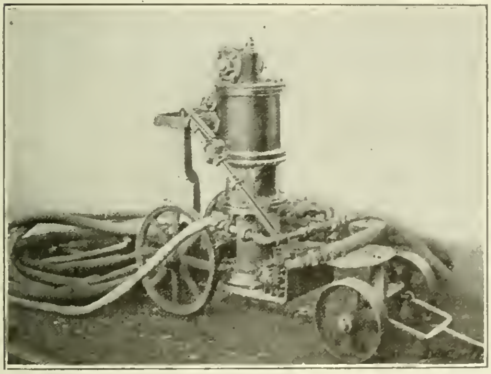
Valve-Cord—A cord or rope by pulling on which from the basket the valve in the top of the balloon is opened so as to allow the gas to escape and the balloon to descend.

Rip-Cord—A cord or rope sewn into the fabric of a balloon by pulling on which a large rent is made in the balloon so as to permit of the quick escape of the gas; necessarily used in making a landing in a strong wind.

Barometer—An instrument which shows the ascensional height by constantly indicating the changes in air-pressure due to increase or decrease of altitude as the avio or balloon goes up or down.

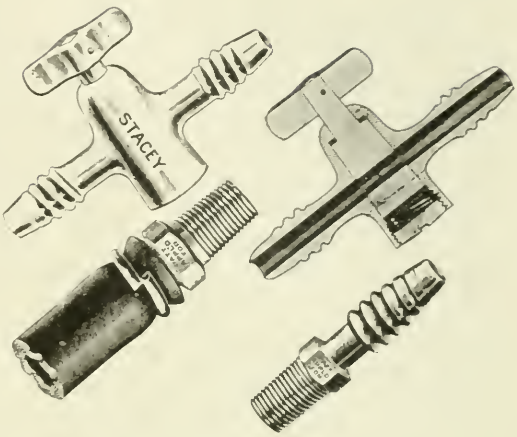
Anemometer—A small wind wheel, operated by the wind; by its use the velocity of the wind being known, the distance traveled and speed attained can easily be computed.

Hygrometer—An instrument which indicates the percentage of moisture in the air.



A PORTABLE LOCOMOTIVE BOILER TESTER

A very convenient apparatus for testing locomotive boilers is in use in the Fort Wayne shops of the Pennsylvania Railroad. The device consists of a powerful water pump operated by air, which is mounted on a truck as shown in the illustration. This machine, together with the necessary hose, is easily moved to wherever it is needed; the air hose is then connected with the regular shop air supply and the water suction hose with the water supply. The discharge end of the water hose is coupled to the inlet valve on the boiler. The pump is then started and the cold water pressure run up to the desired point. After the test is over, the air and water hose are coiled around the pump cylinders and the machine is moved out of the way until it is again wanted.—*Machinery.*



PNEUMATIC STOP COCK AND HOSE NIPPLE

The cut herewith shows a pneumatic stopcock and a steel nipple for use with air hose for rock drills, pneumatic tools, etc., and they both speak for themselves as to their points of excellence. This steel nipple is claimed to be the only one manufactured which can be used on any ordinary tool hose without wire fasteners or hose bands, on account of the forming of a vacuum and forcing the hose to lock of itself upon the nipple. It screws in easily, with a left hand thread, so that the hose will not be disturbed when unscrewing a pneumatic tool, and the insertion of the nipple will not injure the hose. On old or much worn hose a spring is used as shown, this being furnished with the nipple. One end of the nipple has the standard pipe thread.

The stop-cock has a right hand thread on one end and a left hand thread on the other so that it can be inserted and screwed entirely into two hose ends without turning the hose. The springs, when required, can of course be used here as well as upon the nipple. The plug is held to its bearing by a spring which gives the required pressure to keep it always tight. The surfaces of the plug at each end are sufficient to preclude all possibility of leakage and ensure very slow wear. The plug is oiled sufficiently each time the cock is opened to secure unfailing lubrication. Both the articles here mentioned are manufactured by the Harrison Supply Company ,Boston

PNEUMATIC DISPACTH TUBE

The pneumatic dispatch tubes used on the Pennsylvania railroad between the inspection pits and the roundhouse foreman's office, for the purpose of quickly forwarding inspection reports, were thus described by Mr. William Elmer, master mechanic on that road at Pittsburg.

The dispatch tube is made of 2-in. pipe laid in a box underground or carried on the ends of ties; corners are turned with easy curves. The fins are smoothed off the inside of the pipe and a simple carrier can be made of an old air brake hose. When the inspection reports are ready they are slipped into the carrier and the latter pushed into the open end of the tube. A hinged flap valve is then held against the tube and the air pressure turned on, a distance of several hundred feet can be traversed in a few seconds. As almost all our large engine houses are provided with air compressors, it is easy to secure the air pressure needed by using a reducing valve set to a few pounds. The carriers as they come out of the tube strike against a spring buffer a foot or so away and drop into a basket. The man at the receiving end then signals to the other end by means of a bell or incadescent lamp and the air is shut off and the flap valve allowed to fall.

LUMINOUS PROJECTILES

The elaboration of the warship continues without intermission. It is proposed to supplement searchlights with guns firing projectiles which will emit intense lights, either during their flight or on striking the water. For the latter service calcium carbide is the most suitable. The latest form of carbide bomb comprises two cylindrical wooden shells, which telescope together. The inner shell is filled with calcium carbide, calcium phosphide, and gunpowder, not mixed together. It has an iron head and, at its opposite end, an orifice for the escape of gas. The two wooden cylinders separate immediately on leaving the muzzle of the gun and the inner cylinder continues its flight alone. On striking the water the projectile, after the first plunge, rises to the surface. Water enters the shell and evolves acetylene from the carbide, and hydrogen phosphide or phosphureted hydrogen from the calcium phosphide. The hydrogen phosphide ignites spontaneously on contact with the air and sets fire to the acetylene. The flame is not extinguished, but rather brightened, by contact with water, so that an intense light is produced even in a high sea. An intensity of 2,000 candles and a life of three hours are claimed for these acetylene bombs, and they can be projected to distances of two miles or more.

A WIDOW WITH A PROPOSITION

We have great admiration for the prospector and the splendid work he has done, and we never have, where possible, failed him. And surely now, when the call comes from one of the gentler sex, who says she is a widow, but not a "merry widow," nor a romance seeker, nor a husband hunter, but just a young, strong, ambitious woman—a prospector, we feel impelled to extend what aid we may. Tiring of "grub-staking" common man, who brought forth no results, she started out herself and braved the terrors of the desert, accepting the lot of the prospector, with its privations, its heat and cold, its thousand and one things that tax the courage of the bravest. Despite all these she persevered and finally "struck it rich." She writes that she is not soliciting any pastime correspondence but with a strictly business motive offers a half interest in her discovery to any right-minded man who will incorporate and finance her property. We believe that there is some masculine heart yearning to demonstrate beyond peradventure that the age of chivalry is not dead, who stands ready to aid this widow, who is not a "merry widow," but just a brave and ambitious woman prospector.—*Mining World,* Chicago.

Aluminum paint is made by blowing air or gas through molten aluminum while it is setting and at the same time stirring violently. This forms a spongy or granulated metal that is easily pulverized.

There is a difference between benzene and benzine; the former, the more correct name for which is benzole, is a definite chemical compound having a moleculor formula $C6 H6$ and mostly obtained from coal tar by fractional distillation, while benzine is the name given to one of the volatile products obtained in the refining of crude petroleum.

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NEW YORK STATE BARGE CANAL

It would seem that this great work is receiving far less than its share of attention and appreciation. Here is an enterprise second only to the Panama Canal in magnitude and importance. This canal is being constructed from the Hudson River to Lake Erie to take boats 300 ft. long, 40 ft. beam, and 10 ft. draft, capable of carrying a cargo of 2,500 tons. The present canal accommodates barges 78 ft. long, 17½ ft. beam, 6 ft. draft, carrying 240 tons. The original Erie Canal, opened in 1825, took boats 61 ft. long, 7 ft. beam, 3½ ft. draft, carrying 30 tons or 1,000 bushels of wheat.

No portion of the old canal is used from the Hudson at Troy to Rome. The channel of the Mohawk is used most of this way, it being improved by means of a Poiree needle and twelve dams. From Rome the route includes Wood and Fish creeks, Oneida Lake, the Oneida, Seneca and Clyde rivers, a part of Ganargura Creek, and across various streams to Rochester; thence by enlarging the present canal to Buffalo. The Champlain and Oswego canals are to be enlarged at the same time. The canal sections will have a width of 75 feet at the bottom and 123 feet at the water level, and the water depth of all sections is to be 12 feet, sufficient for barges of 2,000 tons.

The total length of the new canals will be 442 miles, of which 407 miles will be contract work. Up to February 1 of this year contracts amounting to $35,771,815 have been let and are under way, slightly more than one-third of the total estimated expenditure. The total excavation to the date named was 15,381,627 cubic yards, and the total concrete placed 424,157 cubic yards.

Contract 12, from Brewerton to Fox Ridge, near Syracuse, a distance of 43.7 miles, is the largest contract yet placed. It includes the excavation of about 7,000,000 cubic yards, including 1,100,000 cubic yards of solid rock and the placing of 20,000 cubic yards of concrete. The contractors are the Stewart Kerbaugh-Shanley Company of New York City. Steam shovels and side dump cars are used for earth and rock excavation; Page scraper buckets on the levees; orange peel buckets and dipper dredges for subaqueous rock; hydraulic and ladder dredges for soft material under water; drill boats; well and rock drills for blast holes, representing an investment of about $900,000.

The contract runs from a point in Oneida Lake to its outlet in the Oneida River and down the latter to the Brewerton cut and then across the land to cut off a bend in the river. Soft muck and sand were expected in the river, and for this section a hydraulic dredge built by the Bucyrus Company and two ladder dredges were employed. A hard, cemented gravel was found, the dredges were kept at the work and went through the material successfully, the hydraulic dredge excavating a maximum of 135,000 cubic yards a month. From July 7, 1908, to December 1, 1908, it excavated 447,000 cubic yards, working three 8-hour shifts per day. The material from the pipe line must be discharged behind the dikes and levees to prevent its moving back into the channel.

AMERICAN SOCIETY OF ENGINEERING CONTRACTORS

A permanent organization of this society was effected on April 15, at the United Engineering Society Building, New York. The officers for the first year are as follows: Geo. W. Jackson, of Chicago, President; Halbert P. Gillette, of New York, First Vice-President; D. E. Baxter, of New York, Second Vice-President, and Daniel J. Hauer, of New York, Secretary.

This new national society begins its career with nearly 1,500 members. Corporate members must be engineers, contractors or manufacturers of engineering materials or equipment who have been engaged in these lines for at least 7 years; a degree from a college of standing counting as two years of experience. Applications for membership may be made to the Secretary, at his office 721 Park Row Building, New York.

A LAST WORD ON LEAKY DISCHARGE VALVES

The following note, which sufficiently explains itself, appeared in a recent issue of *Power and the Engineer*:

Mr. W. E. Turner says that he "can hardly agree" with me that leaky discharge valves in air compressors are not a cause of abnormal heating of the air, and consequently of explosions which occur in compressed-air pipes.

Mr. Turner says: "If on account of leaky discharge valves the intake, or suction valve on that end does not lift, is it not an evident fact that as the piston moves back and forth there is a continual displacement, or churning, of air going on?"

In that case the compressor ceases to be a compressor. If it heats the air it does not deliver it, or send it along into the discharge pipe. In an indicator card from an air compressor in normal condition, when the return stroke begins, the re-expansion line drops to atmospheric pressure very quickly, and for the intake stroke the line is slightly below the atmosphere, showing that the cylinder fills with free air to be compressed and delivered upon the next stroke, and yet we know that explosions occur with compressors which thus indisputably take in and deliver nearly a cylinderful of air for each stroke.

Mr. Turner should submit some indicator cards from the alleged compressors in which the intake valves cannot and do not open, as he assumes, on account of the freaks of the discharge valves. I am not clear as to how the same air can remain and play back and forth in the cylinder and become intensively overheated and at the same time be flowing along the discharge pipe.

FRANK RICHARDS.

RAPID MINE DEVELOPMENT ON THE RAND

Some very rapid development has been carried out in the Van Dyck mine. It may be recalled that during November last 323 feet were made in 62 shifts of 9½ hours each by two miners working on the 5th level east, No. 1 shaft. One white man and five natives worked each shift, using two Ingersoll-Sergeant drills. In December an average rate of footage per face of 217.36 feet was attained. During 1908 the total footage driven, sunk and risen in the Van Dyke property came to 10,216.5 feet, in addition to which 721 feet were done on account of the Apex Mines, Ltd. (Gold Section), making a grand total for the year of 10,937.5 feet. Of the total footage in the Van Dyke mine proper, 8,334.5 feet were in respect of drives and 733.5 feet in the incline shaft.—*South African Mining Journal.*

TRADE PUBLICATIONS

SMOKE BOX SUPERHEATER, FEED WATER HEATER, Record No. 66, Baldwin Locomotive Works, Philadelphia, 32 pages and cover, 6 by 9 inches. Various typical locomotives are shown and described embodying these improvements. Text mostly reprinted from *Railroad Age Gazette.*

VALUABLE GRAPHITE PRODUCTS, Joseph Dixon Crucible Co., Jersey City, N. J., 24 pages and cover, 3½ by 6¼ inches. Graphite in various styles for lubrication, pencils and crayons, crucibles, stove cement, belt dressing, graphite brushes, are the products treated of.

CAMERON CONDENSING APPARATUS, Cameron Steam Pump Works, New York. The special adaptabilities of centrifugal condensers, barometric jet condensers, and surface condensers are treated of with the operating pumps and other appurtenances.

THE ST. JOHN INDICATING AND RECORDING AIR-METER, by G. C. St. John, 140 Cedar St. New York. 28 pages and cover 6¼ by 9¼ inches. The instrument described in the pamphlet measures and makes permanent record of the quantity of free air or gas flowing through it at whatever pressure. The principle upon which it operates is that with a uniform difference of pressure on two sides of an orifice through which air is flowing, and a constant initial pressure and temperature, the quantity of air passing bears a direct relation to the size of the orifice.

MINE EXPLOSIONS: THEIR CAUSE AND PREVENTION*

Notwithstanding the advancement made and knowledge gained, scientifically, technically and practically, by experience and costly exhaustive investigation and experiments in past ages, we seem to get no nearer the solution of the great problem of devising means to prevent those lamentable and too frequent occurrences.

Recently, whenever we hear of a mine explosion, the report is either accompanied with the statement, or the statement soon follows, that the mine where it occurred was a "model mine," and that "no cause could be assigned for the explosion."

A "model mine" too often consists of an outward or surface display of fine, costly machinery and other equipments and supplies; in many instances more than necessary to enable those in charge of the mine to operate it in a manner that will protect the employes from all seen, and most unseen, dangers from mine explosions. When companies are willing to provide everything necessary to care for and protect the lives of their employes, and their property, and hire what are considered competent men to take charge, it is a grave reflection on some one that such calamities should occur.

Another feature in connection with mine explosions is that there are always a number of people ready to impress upon the public the idea that such calamities are unavoidable, and their cause of mystery beyond human skill to explain. There is no mystery about the cause of explosions in mines, and no logic in the argument that they are unavoidable. They are the result of accumulations of carburetted hydrogen gas and coal dust, in most instances the former being set in motion by contact with flame, and the explosion being increased and intensified by the ignition and explosion of the dust, to the extent of the amount of the accumulation and the fixed carbon and volatile combustible matter contained in it

The higher the carbon in coal dust, the more intense the heat, the greater the expansion of flame, and the more destructive the force

Gas accumulates in mines from defective ventilation, the air current not being conducted to the interior of the mine on account of bad doors, leaky stoppings, blocked airways, or ventilating fans being stopped while the mines are in operation, as per the evidence adduced before the coroner's inquiry in the Marianna explosion in Pennsylvania last December.

If the ventilating fan is capable of producing the necessary current of air, and the ventilation in the mine is cared for as it ought to be, there can be no danger from accumulations of gas

If coal dust is sprinkled when necessary, and removed from the mine as it should be, and not allowed to be thrown back on the gob piles, or used for ballast on the haulways (as it is in many instances), there can be no danger from accumulations of coal dust.

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*Abstract of address to Mining Students, Ohio State University, by George Harrison, Chief Inspector of Mines.

If coal is properly undercut and prepared before blasting, and the drill holes drilled and power gauged with practical skill and good judgment, as they should be, there can be no fear of danger from blown-out shots.

Mine explosions are liable to occur at any season of the year, and under all weather conditions, but they more frequently occur in the winter season, during sudden changes of weather, especially with a low barometer, or rising thermometer, or both.

ATMOSPHERIC CHANGES AS AN INDEX.

Before safety lamps and ventilating fans became in general use in mines, old miners were very diligent in their observations of atmospheric changes, the theory being that a high atmospheric pressure had a tendency to press the gas back in the strata in mines and reduce the flow for a time below the normal amount generated; but, just as steam rushes from a steam boiler when the weight on the safety valve is reduced, as soon as the barometer began to fall, and the pressure was relieved, the extra amount of gas pent up by the heavy pressure suddenly flowed from the joints and fissures in the coal and roof, and the furnace power was so affected by the reduced pressure, and probably also by a rise in the temperature at the same time, that the air current was diminished and inadequate to dilute the extra flow of gas, thus permitting gas to accumulate and increase the liability of an explosion.

The adoption of fan ventilation in mines is a great improvement over the old system of furnace ventilation, and is well calculated to overcome the effect of sudden changing weather conditions on the ventilation and safety or danger in the operation of mines, especially mines generating dangerous quantities of fire-damp.

If a barometer and thermometer were placed at every mine, and closely observed, particularly in the winter season, by the engineer who has charge of the ventilating fan, and the speed of the fan increased or reduced as weather conditions indicated it should be, the general public would not be so often horrified by the unnecessary destruction of human life in the mines.

A safety lamp, unless its properties and uses, and the danger of tampering with it, are generally understood, is like the insulation on a highly charged electric wire in a mine; it is a danger in disguise. Sir Humphrey Davy and others conferred a great boon on the mining communities in foreign countries when they invented and perfected the safety lamp for use in gaseous mines, but in some respects the lamps have been an additional danger, and through their misuse, thousands of miners have been launched into eternity without a moment's warning, which ought not to have been if too much dependence had not been placed on the safety lamp, and too little attention given to the unnecessary accumulation of large and dangerous volumes of fire-damp.

THE USE OF SAFETY LAMPS.

Safety lamps can and may be used to great advantage in leading headings in gas-producing mines, especially where such places are raising rapidly and it is difficult to conduct a large volume of air to dilute and render harmless such gases, or in crossing clay veins or faults where feeders of gas are usually encountered; and even in such cases they should be placed in the hands of men selected for their good judgment, experience and carefulness. To introduce them in a general way in placing them in the hands of a very large majority of men, especially in this country, who know nothing of their properties or uses, and placing the lives of every employe in the mine in the hands of every individual who enters it, and it ought not to be done without the most careful and serious consideration, and that only when the flow of gas is so great that it cannot be reached and dispersed by a volume of air.

An adequate, and never-ceasing volume of pure air conducted throughout the interior excavations of a mine, and the prevention of the accumulation of the elements of danger by a strict and constant vigilance on the part of those intrusted with the management, is the safer, less expensive and more satisfactory way of preventing mine catastrophes. Strike at the root, remove the primary cause of mine explosions, and there will be no necessity to search the pockets of the dead miners, after an explosion, to find if they were carrying pipes, smoking-tobacco, and matches, to the mine, as a subterfuge to relieve some one who had neglected an important duty, from grave and serious responsibility.

In a railroad wreck, an investigation usually discloses the fact that it was caused by a neglect of duty; a violation of orders; a broken rail; an open switch, or a defective joint; but in a mine explosion (fortunately for some people), the evidences as to the cause are usually obliterated by the force and destructiveness of the explosion, and the unsuspecting public is advised that such occurrences are unavoidable, and no cause for them can be assigned, when if the truth could be known there is little doubt that there was an "open switch," or in other words, a woeful want of necessary discipline and proper observance and application of law.

THE USE OF ELECTRICTY IN MINES.

Without going into details, let me also impress upon you that the general use of electricity in mines; the use of coal-cutting machinery and high-speed haulage methods, as well as the increase in the number of deep shaft mines, with reckless methods of mining and excessive use of flame-producing explosives, are all factors of danger, that under favorable circumstances and conditions very materially affect the atmosphere of mines, and often-times cause serious and dangerous vibrations of the ventilating current, increasing the liability of mine explosions if the treacherous foe is lurking around, ready at first opportunity to prey upon his unsuspecting victims.

ELECTRICITY AND ELECTRIC MACHINES IN COAL MINING

The following we take from a paper read before the Elizabeth, Pa., Mining School by Mr. Joseph Bennett, a practical miner of the bituminous coal region:

Now, since coal dust and black powder have become so dangerous in coal mining, it has caused a great deal of comment throughout the country as to which should be taken out of the mines—black powder or the machines that are producing so much dust as to make the mines dangerous? To my belief electric chain machines should be taken out of all mines generating explosive gas, for such machines are dangerous. In under-cutting the coal, the chain machine grinds the finest of dust and produces more of it than any other machine that I have ever seen or had experience with in mining coal. The electric chain machine also heats the atmosphere of a mine while the machine is in operation. This brings the dust in such places as give off a small percentage of gas and makes them dangerous. I have seen places where open lights and the electric chain machines were used, when the men running the machine would not put their open lights down near the under-cutting for they knew that it would cause a small explosion. In the same mine compressed air machines were in use previous to the electrical, and while the compressed air machine was under-cutting the coal the open lights were constantly on the bottom—often set under the under-cutting 18 inches—and such a thing as an explosion was not known.

In my opinion compressed air is 90 per cent. safer for mining coal than electricity. The exhaust from the compressed air machine has a cooling effect on the atmosphere of a mine and gives off more or less moisture. The moisture helps to still the dust and keep the atmosphere of the mine at a lower temperature. Now, since black powder has been proven to be such a menace to mining, it should not be used for blasting purposes in coal mines, but should be strictly prohibited; and so should electricity in mines generating explosive gas, for I believe that when one of these dangerous factors of coal mining has to be taken out the other should be taken with it. The laws governing the use of black powder and electricity in coal mines should be Federal laws, and such laws should be put into effect without ifs and ands, for the world has seen within the last two years that black powder, electricity and the dust that is being produced by the electric chain machines have been dangerous.

I am not of the same opinion as an electrician of West Virginia who, a short time since, wrote his opinion concerning electricity in mines. He stated in his writing that he did not believe it right to hurt the mining industry for the sake of saving a few lives. He must remember that a miner's life is just as dear to him as that of any other class of workmen in the world today

I do not believe the mining industry would be hurt by taking out electricity, for I believe the same production of coal can be taken from mines with other than electric machines and with less danger. The mine laws of the present time, if obeyed, would put electricity down and out in mining coal in the bituminous fields.

NOTES

The Ingersoll Rand Company has recently sold an air compressor to supply air, as mentioned in the order, for "putting trousers upon sausages."

The Bowery Mission Free Labor Bureau announces that it is prepared to supply any number of men, for any kind of labor, at a moment's notice. Address John C. Earl, Financial Secretary, 92 Bible House, New York City.

The total number of passengers carried per day by the surface, elevated and subway cars in the entire city of New York is about 3,500,000, while in the Borough of Manhattan alone 6,500,000 are carried up or down by the 8,000 passenger elevators.

The longest pipe line on earth is being constructed by the Cincinnati gas interests in the development of their project to conduct fuel from West Virginia and Kentucky gas fields to Cincinnati. The distance will be from 160 to 200 miles and the pipe will be 18 and 20 inches in diameter.

The Eagle Point Lime Works, Eagle Point, Ia., have further modernized their plant by the installation of a complete system of compressed air for drilling and blasting and other purposes in their quarries. The system works perfectly, and will enable the concern to accomplish about twice as much work as formerly.

Atmospheric pressure is 14.7 lbs. per. sq. in. at sea level; at 1,000 ft. elevation, 14.13 lbs.; at 2.000 ft., 13.58 lbs.; at 3,115 ft., 13.05 lbs.; at 4,169 ft., 12.54 lbs.; at 5,225 ft., 12.0 lbs.; at 6,300 ft., 11.56 lbs.; at 7,300 ft., 11.1 lbs.; at 8,000 ft., 10.8 lbs.; at 10,000 ft., 10.0 lbs.; at 12,000 ft., 9.3 lbs.; at 14,000 ft., 8.6 lbs.

Experiments to determine the relative efficiency of aerial and underground lines for telephone purposes have recently been made at Newcastle, England. Speaking from Newcastle to London (nearly 300 miles) was successfully accomplished with the aerial wire, but with the underground cable the voice became almost inaudible at forty-eight miles.

While sulphuric acid is probably the most important of all chemicals, immense quantities being made yearly, the greater part does not come upon the market; for, being expensive and difficult to ship, consumers of large amounts generally make their own acid.

At Zuber's stone quarry, near Gladsden, Ala., sixteen men were eating their noon meal. Otis Browne, a fat man weighing 260 pounds, had finished his meal and was lying down on his back to sleep. 200 feet above a negro was carrying a 40-pound box of dynamite. The negro slipped and the 40-pound box fell the 200 feet, striking the fat man, Browne, after which it bounced harmless to the ground.

When red hot coke is quenched in cold water the at first somewhat surprising result occurs that three or four times as much water is taken up as is absorbed by the same coke when dipped into hot water. Coke has many pores which remain filled with air or gas even when dipped in water, and with a rise in temperature the gases diminish in density, so that at a bright red heat the real quantity of gas contained is not more than a quarter of what it would be if the coke were cold, and quenching the bright red coke therefore imprisons in the pores only one fourth the quantity of air or gas, allowing three or four times as much water to fill the pores instead.

The great improvements in mining in recent years have made it possible to extract a dollar's worth of gold at about what it cost to get a half-dollar's worth a few years ago. More than this, some of the best paying gold mines here and abroad are working none but ores which twenty years ago could not have been worked at a profit. Mines, as manufacturers of credit for the communities in which they are situated, are blessings to all channels of commerce.

The mean height of all the land now above the sea is about 1000 feet, and the mean depth of the ocean is at least 12,000 feet. The extreme heights of the land, although probably no less than the extreme depths of the sea yet are exceptional heights, while the ocean maintains its depths over enormous areas. As the surface of the ocean is two and a half times that of the land the ocean would give place to all the land above sea level thirty times over.

Although coal-cutting machines were introduced in Great Britain fifty years ago, in 1902 there were only 166 machines used in that country, while in 1907 there were 1,493. In the United States in the year 1906, there were 10,212 machines in use, and the percentage of the total coal mined by machinery was more than 30 per cent. Each machine used in the United States showed an average annual production of 11,638 tons, which compares with 8,630 tons in Great Britain.

As Victor Hugo prophesied he would, man has already improved on Nature's work in the field of chemistry, in more ways than one. Calcium carbide, a compound of pulverized limestone and carbon, out of which acetylene gas is made, and carborundum, a compound of quartz sand and carbon, an abrasive second in hardness only to the diamond, which has, to a large extent, driven emery out of the market, are each of them synthetic products of the electric furnace, purely man-discovered and man-made, never yet found on land or sea, in Old Mother Nature's workshop.

In order to test whether or not his apparatus for the prevention of mountain sickness is a success, Prof. David P. Todd will conduct experiments in ballooning. It is Prof. Todd's idea to establish on some lofty peak an astronomical observatory, in the clear atmosphere of which it will be possible to make better astronomical observations than are now obtained. To carry out that idea, he intends first to ascertain whether or not mountain sickness can be be prevented at elevations exceeding 6,000 feet. He has devised a special apparatus for supplying compressed air which he hopes may attain the object.

The explosion of a carbonic acid tank while under considerably less pressure than that for which it was sold by the manufacturers resulted in the death of a man nearby. His administratrix brought suit against the manufacturers. The decision of the court, 154 Fed. Rep. 121, was to the effect that the manufacturer of a thing inherently dangerous, or which becomes dangerous when applied to its intended use, who sells it for such use, is liable in damages to anyone who, without fault on his part, sustains injury which is the natural and proximate result of the manufacturer's negligence.

The irrigation works of the federal government in the western states will include three of the greatest dams in the world. The Shoshone dam, with a height of 326 feet and the extremely short length of 175 feet will store 456,000 acre-feet, 148,975,200,000 gallons; the just completed Pathfinder dam, 215 feet high and 226 feet long, will store 334,867,500,000 gallons; while the Roosevelt dam, 284 feet high and 1,080 feet long will store 419,482,800,000 gallons. The Assouan dam on the Nile, the most notable structure comparable with these, after the work of increasing its height has been completed, will impound 1,860,000 acre-feet, or 607,662,000,000 gallons.

For more than 50 years the people of Constantinople have not witnessed a balloon ascent. During the lifetime of the present Sultan's father, Abdul Medjid, an Englishman ascended in a balloon before the eyes of the astonished Turks; but Abdul Hamid saw in the balloon a likely means of dropping bombs down upon the palace of Yildiz, and he forbade any balloons to ascend in or near Constantinople As such fears have vanished the prohibition has been withdrawn, as the Minister of War has given permission to a Frenchman to inflate his balloon with the aid of Turkish soldiers in the Pera suburb of Constantinople, to the north of the Golden Horn.

Without a visit to a modern fortification or battle-ship and personally witnessing the target practice, one can scarcely comprehend what it all means, so startling have been the developments. For example, projectiles weighing more than 1,000 pounds are now fired at minute intervals from twelve-inch mortars to a height of three or four miles, and a like range, with but twenty-five pounds of smokeless powder, and with such accuracy as to cause every projectile to fall upon the deck of a battle-ship traveling ten miles per hour. These monstrous elements of destruction (a single shot would sink a ship), are fired from pits absolutely protected from the fire of a warship, and but ten per cent. of the manning details are exposed to danger.

The completion of the Cape Town-Cairo Railway in Africa will give the world its longest railroad. It will connect North and South Africa and will be in the neighborhood of 6,400 miles long. The cost when completed will reach close to $1,000,000,000. Although this is an immense sum it is comparatively small when it is considered what it will be to Africa and in fact to the entire world. It will make it possible for the traveller to journey from Berlin or Paris to Cape Town in ten or eleven days. The country which it will open up is rich in almost everything in the mineral world, such as gold, silver, copper and diamonds. Only 2,500 miles is yet to be completed, which is between Khartum, in the British Egyptian Soudan, and Broken Hill, a point in Rhodesia.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

MAY 4.

920,129. MILKING APPARATUS. Ezra E. Good, Waterloo, Iowa.
920,202. AIR-ENGINE. Albert E. Smith, Chicago, Ill.
920,373. AIR-VALVE FOR RADIATORS. William P. McDaniel, Omaha, Nebr.
920,389. AIR-BRAKE. Frank B. Rae, New York, N. Y.
920,421. GAS-COMPRESSOR. William J. Boland, Chicago, Ill.
920,443. AIR-PUMP FOR CARBURETERS. Alexander D. Elliott, Viola, Ill.
920,491. FLUID-PRESSURE CONTROLLER. Thomas O. Perry, Chicago, Ill.
920,504. FLUID-PRESSURE BRAKE. Walter V. Turner, Wilkinsburg, Pa.
920,584. APPARATUS FOR PURIFYING AIR. Karl Kosak and Richard Herz, Vienna, Austria-Hungary.
920,631. THROTTLE-VALVE MECHANISM. Samuel Oldham, Philadelphia, Pa.
920,744. PNEUMATIC ACTION FOR SELF-PLAYING INSTRUMENTS. Emory C. Hiscock, Chicago, Ill.
920,788. SELF-TIGHTENING ROCK-DRILL CHUCK. James A. Thompson, Edwin M. Mackie, and Percival F. Doyle, Chicago, Ill.
920,792. WINGED PROPELLING AND GUIDING MECHANISM FOR AIR-SHIPS. Julius Uherkovich de Uherkocz, Bayonne, N. J.
920,811. PROCESS OF STERILIZING. Arthur J. Baldwin, East Orange, N. J., and James F. Lester, New York, N. Y.

4. The process of sterilizing substances of the kind described, and preventing the growth or development of bacteria therein, which consists in subjecting such substances to a sustained air pressure.

920,855. AIR-BRUSH. Leonard Forester, Steubenville, Ohio.

MAY 11.

920,997. VACUUM-PAN FOR EVAPORATING APPARATUS. George R. Ray, Manistee, Mich.
921,010. COMBINED FORCE-PUMP AND SPRAY-TANK. Roscoe S. Sheldon, West Allis, Wis.
921,019. HOT-AIR HEATING SYSTEM. Robert G. Speer, St. Louis, Mo.
921,040. PNEUMATIC SUCTION-PUMP. David T. Williams, Paterson, N. J.
921,130. SYRINGE. Benjamin F. Lockwood, Frewsburg, N. Y.

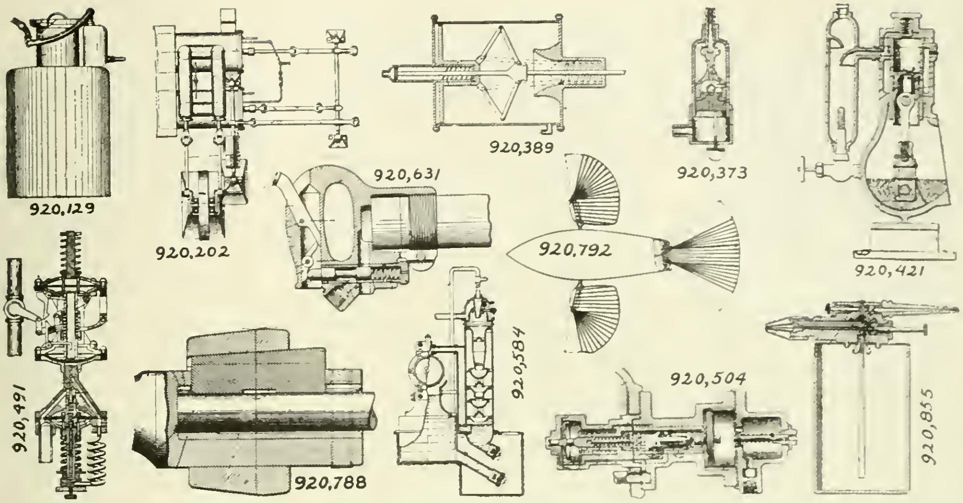
1. A receptacle for *fluid under pressure* consisting of an air tight receptacle, and a resilient air tight sack within said receptacle containing air under pressure to eject the fluid from said air-tight receptacle.

921,155. COMPRESSION-PUMP. Frank G. Perez, San Francisco, Cal.
921,164. COMPRESSOR, VACUUM-PUMP, AND THE LIKE. Ferdinand J. Rochow, Brooklyn, N. Y.
921,174. PNEUMATIC TIRE. William H. Snyder, Kenton, Ohio.
921,240. VALVE MECHANISM FOR CHANNELING-MACHINES. Harry V. Haight, Sherbrooke, Quebec, Canada.
921,307. VACUUM DRYING APPARATUS. Emil W. Strohn, Buffalo, N. Y.
921,341. PNEUMATIC STRAW-STACKER. Simon M. O. Bangen, Crookston, Minn.
921,365. HUMIDIFIER. Alfred R. Clarkson, Birmingham, Ala.
921,409. COMPRESSED-AIR SPRAYING AND COATING MACHINE. Robert M. Johnston, Mansfield, Ohio.
921,420. FLUID-CONTROLLED DRILL-BIT SWAGING AND SHARPENING MACHINE. John G. Leyner, Denver, Colo.
921,515. MEANS FOR USE WITH BALLOONS AND OTHER AIR VESSELS FOR INDICATING AIR-CURRENTS. Charles Davis, London, England.
921,632. PORTABLE PNEUMATIC PUMPING APPARATUS. John W. Smith, Philadelphia, Pa.
921,654. LIQUID-MEASURING APPARATUS. Henry Pein, Jersey City, N. J.

1. A measuring device for liquids comprising a receptacle for a liquid, an air tight chamber; means whereby the air may be transmitted from one of said chambers to the other, and a valve adapted to control the passage between the said liquid and air chambers.

MAY 18.

921,669. PNEUMATIC CLEANING APPARATUS. Carl W. E. Boegel, Lima, and James C. Lewis, Mansfield, Ohio.
921,710. PNEUMATIC TIRE. Grant Jacobs, Des Moines, Iowa.
921,764. BLOWER FOR PEAS OR THE LIKE. Albert H. Wheeler, Worcester, Mass.
921,793. APPARATUS FOR AUTOMATICALLY STOPPING STEAM AND ELECTRIC TRAINS AND SIGNALING THE ENGINEER IN CHARGE. George P. Burke, Louisville, Ky.
921,803. CONTROLLING DEVICE FOR TWO-STAGE COMPRESSORS. Rudolph Conrader, Erie, Pa.
921,890. COMPRESSOR. Frank A. Rider, Pittsburg, Pa.



Pneumatic Patents, May 4.

921,915. AIR-SHIP. Ben H. Tingley, Hamilton, Wash.

922,135. VALVELESS PNEUMATIC TOOL. Frederick S. Graham, Philadelphia, Pa.

922,183. AERATING-MACHINE. Hubert Pearce, Stanstead Abbots, England.

922,228. AIR-SHIP. Michael H. Whalen, New York, N. Y.

922,318. AIR-BRAKE SYSTEM. Edwin J. Newton, Chicago, Ill.

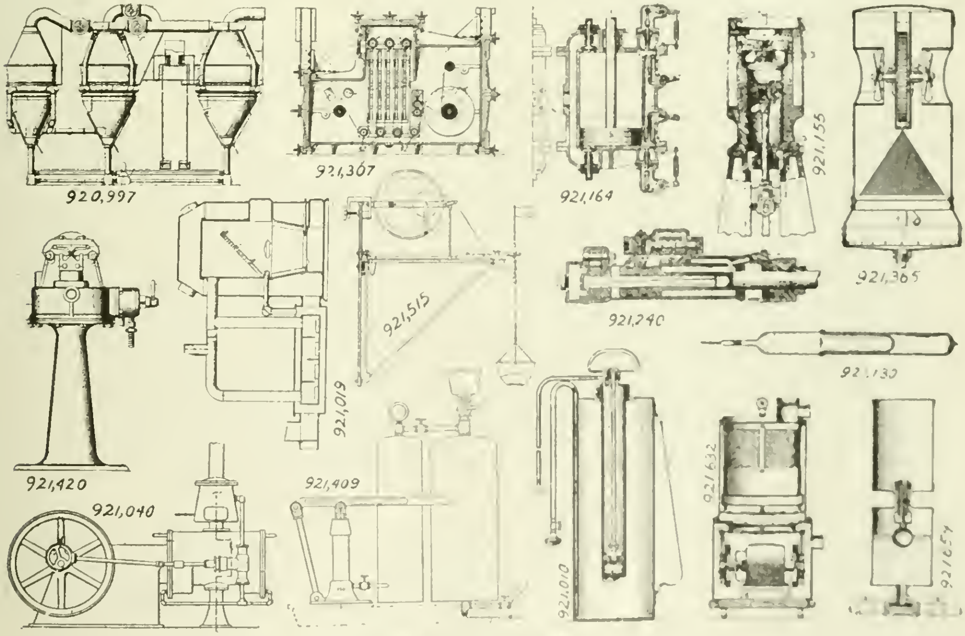
922,342. GLASS-BLOWING MACHINE. Harry A. Schnelbach, Crafton, Pa., and Edward J. Schatz, Marion, Ind.

922,431. TUNNELING APPARATUS. Henry Japp, New York, N. Y.

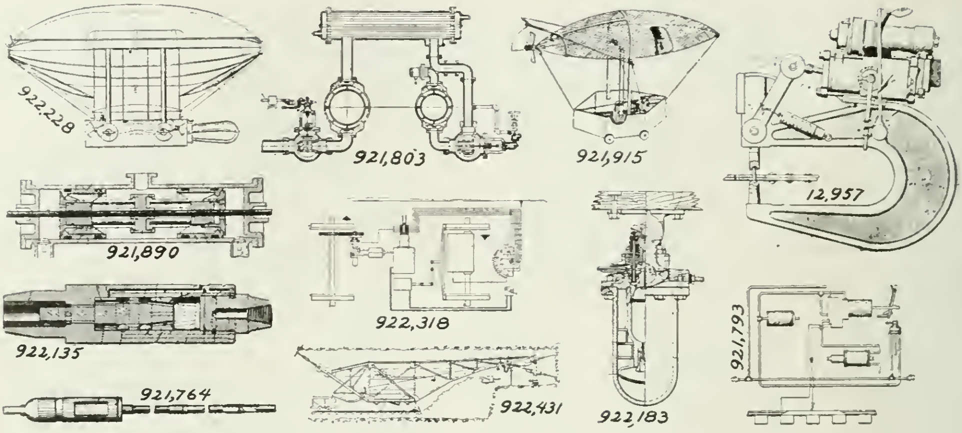
12,957. POWER APPLIANCE. Morris C. White and Otho C. Duryea, Los Angeles, Cal. (Reissue.)

MAY 25.

922,526. WATER-FEED, DUST-LAYING, ROCK-DRILLING ENGINE. Charles H. Shaw, Denver, Colo.



Pneumatic Patents, May 11.



Pneumatic Patents, May 18.

922,531. ELECTRIC AIR HEATING AND DISCHARGING DEVICE. Louis A. Siebert, Columbus, Ohio.

922,549. AIR-SHIP. Samuel D. Wheeler, Chicago, Ill.

922,582. FUMIGATOR. Jacob Hauck, Denison, Tex.

922,595. AIR PUMP OR CONDENSER. Huldreich Keller, Berlin, Germany.

922,603. GAS-EXTRACTOR AND MINE-VENTILATOR. George Laws, Philipsburg, Pa.

922,694. AUTOMATIC AIR-COMPRESSOR. Joseph Gruninger, New York, N. Y.

922,698. SIPHON. Walton Harrison, Bloomfield, N. J.

1. The combination of a siphon tube, and a member of resilient material connected therewith and adapted to fit air-tight upon a receptacle, said member being free to undergo distortion for the purpose of destroying its air-tight fit.

922,840. SAWDUST-CATCHING ATTACHMENT FOR CIRCULAR SAWS. Daniel J. Bemiller, Butler, Ohio.

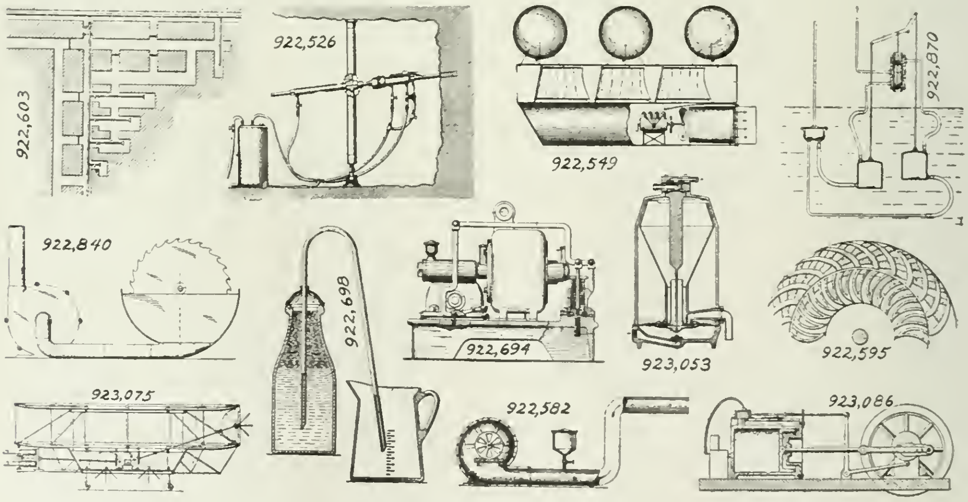
922,870. MEANS FOR RAISING LIQUIDS. Hugo P. W. Esping, Nassjo, Sweden.

3. In a compressed air liquid pump, a submerged vessel free to rise and fall within the liquid, a counterbalanced lever located above the surface of the liquid and having an arm connected with the submerged vessel and extending upwardly at an angle oblique to the surface of the liquid whereby the leverage of said arm is rapidly shortened during the upward movement of thte vessel, means for admitting compressed air to and discharging it from the vessel and means for discharging the liquid from the vessel.

923,053. HYDRAULIC AIR-PUMP. Perry Lewis, Mankato, Minn.

923,075. AEROPLANE. John Potts, Winchester, Ohio.

923,086. ATMOSPHERIC ENGINE. William H. Speirs and Anton Holm, Paterson, N. J.



Pneumatic Patents, May 25.

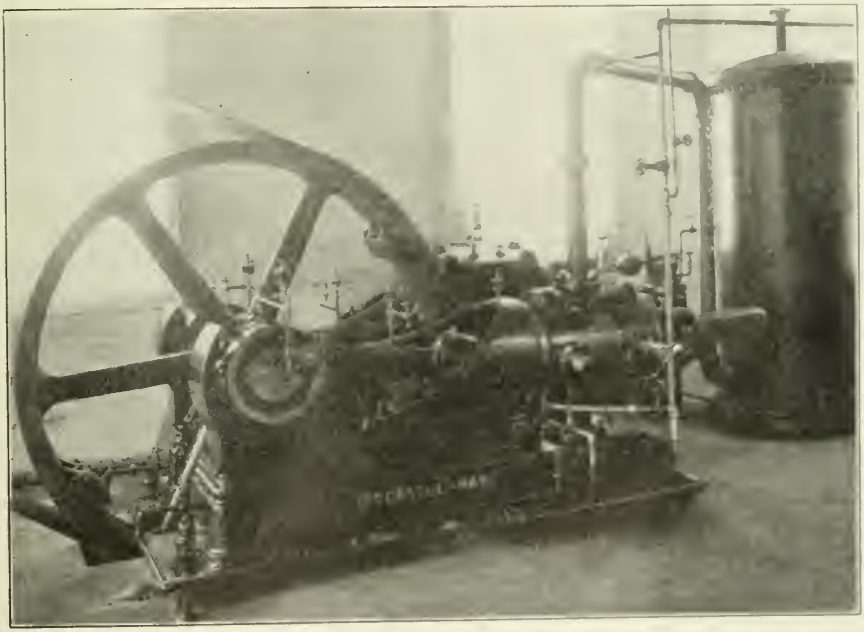
COMPRESSED AIR
MAGAZINE
EVERYTHING PNEUMATIC.

Vol. XIV SEPTEMBER, 1909 No. 9

COMPRESSED AIR IN TEXTILE MILLS

BY ALBERT W. THOMPSON, MECH. SUPT. AMOSKEAG MFG. CO.

Early in 1902 the writer began his experience with compressed air with an outfit consisting of a second hand air brake pump, one three inch chipping hammer and a small piston air drill. This outfit was the "thin end of a wedge" which opened the way for a plant consisting today—only seven years later—of air compressors aggregating in capacity about 3600 cubic feet per minute, permanent distribution mains throughout a territory over a mile in length and nearly half a mile in width and pneumatic service for tools and apparatus of varieties almost too numerous to mention.



400 CUBIC FEET AIR COMPRESSOR, AT AMOSKEAG MANUFACTURING CO.'S PLANT.

The Amoskeag Manufacturing Company, Manchester, N. H., is the largest textile manufacturing plant in the world, and, besides its textile mills, it operates its own machine shop, foundry and boiler shop, also constructing all its own buildings. Its mechanical department naturally provides an extensive field for the use of such pneumatic tools as chipping and riveting hammers, drills, stone tools, hoists, etc., which are too well known to require description here. The writer will therefore endeavor to confine himself to the description of such applications and methods as are peculiarly adapted to mill construction and textile mill service, or which differ from those already widely used.

In mill construction pneumatic service is invaluable, so much so, indeed, that the writer ventures the assertion that the economy secured by the use of pneumatic tools in the construction of a 25,000 spindle mill would pay the entire cost of purchase and installation for a compressed air plant of sufficient capacity to be subsequently used for cleaning and humidifying for the entire mill.

Where rock drills are required in foundation work, air is more convenient than steam, and stone tools of the "plug drill" type are much more efficient than hand work for foundation stone, etc. If old brick are at hand they may be cheaply and satisfactorily cleaned with a small pneumatic chipping hammer, and the cleaned brick are, of course perfectly suitable for wall filling or foundations.

WOOD BORING TOOLS.

The pneumatic wood boring tools can be used to great advantage in mill construction. In the construction of the Coolidge mill now building at Manchester, a man armed with a wood boring machine fits the timbers for anchors and dogs, and easily performs work which would require at least two men with hand tools. Boring tools of the same kind are later used for hanging the shafting, which is carried in hangers, each of which is supported by two three-quarter inch lag bolts. The holes for these lags are bored with a five-eighths inch auger and the lag bolts are then screwed home with the same machine by means of a "blind nut" which fits a socket on the spindle of the boring machine. A gang of seven men will in this manner put up from eighty to one hundred hangers in nine hours, which is at least double the work that the same number of men could perform in the same time with hand augers and wrenches.

The looms in a modern weave room are always driven through the floor, which calls for a large number of belt holes, all of which are generally roughed out with hand augers. For this class of work a pneumatic boring tool may be mounted on ways which are hinged to a flat base. The hinge is adjusted and set at the desired angle, and by standing on the base the auger may be fed and withdrawn very conveniently. The hand machines formerly used at the Amoskeag required two men, one at each crank. With the pneumatic tool two men are still required, both standing on the base of the machine, and each holds one of the projecting handles of the machine. By this means the machine is easily controlled and readily moved, and the two men can now rough out three times as many belt holes as by the old method.

PORTABLE DERRICK.

To set in place the columns and timbers of the mill a portable derrick mounted on trucks is generally provided with a hand hoist operated by six men at the cranks. In building the Coolidge mill a derrick of this type has been equipped with an "Imperial" pneumatic motor with most gratifying results. With the hand machine a gang of ten men could set about five timbers an hour, but with the pneumatic hoist as many as twenty have been set in an hour, and a rate of twelve or fifteen per hour can easily be maintained, even when the work is somewhat intermittent. This apparatus has also been found convenient for other service, such as hoisting bundles of plank from the floor last completed to the floor above in process of construction, the plank being thus delivered exactly at the point where they are to be used.

I. R. CO. IMPERIAL MOTORS OPERATING PORTABLE DERRICK AT NEW COOLIDGE MILL OF AMOSKEAG MANUFACTURING CO.

The rapidly increasing use of cement concrete has evolved concrete mixers of many sizes and types which are in almost universal use for construction work, but for small areas of concrete flooring or machine foundations the concrete is generally mixed by hand on account of the difficulties involved in installing and driving a mixer. In addition to a large mixer, the Amoskeag Manufacturing Co. makes use of a small mixer of the "Cube" type, mounted on a truck and driven by a pneumatic motor, and the outfit is so small and compact that it can be easily moved about by two men and will pass through a door of ordinary size. It is, consequently, instantly available for all concrete work, however small, and is in almost daily use. As mechanically mixed concrete is far superior to hand mixed, and as the labor is reduced one-half, the apparatus pays for itself in a few months.

The methods above described pertain particularly to construction work, but the same tools play an equally important part in the repair and alteration work which is daily necessary in any large mill. Every superintendent and master mechanic knows the value of time in mill repairs, for often the production of a large part of the plant is stopped while a breakdown is being repaired or an important alteration made. Often, too, the location of the work is such that limited space permits only a few hands and tools to be brought to bear upon the work. It is in just such cases that the pneumatic tools are unsurpassed. The ability to bring power to any desired point by coupling up a few lengths of hose at once alters the complexion of a task which would seem almost hopeless where the old-fashioned ratchet drills and hand-chisels were the only tools available.

The wood boring tools are, perhaps, more readily adapted to daily use than any others. They are of great value to electricians for boring through floors or partitions when running wires, etc. They are in constant use in the carpenter shop, both for boring and for driving heavy lag and wood screws, and it is now difficult to imagine how they could be dispensed with.

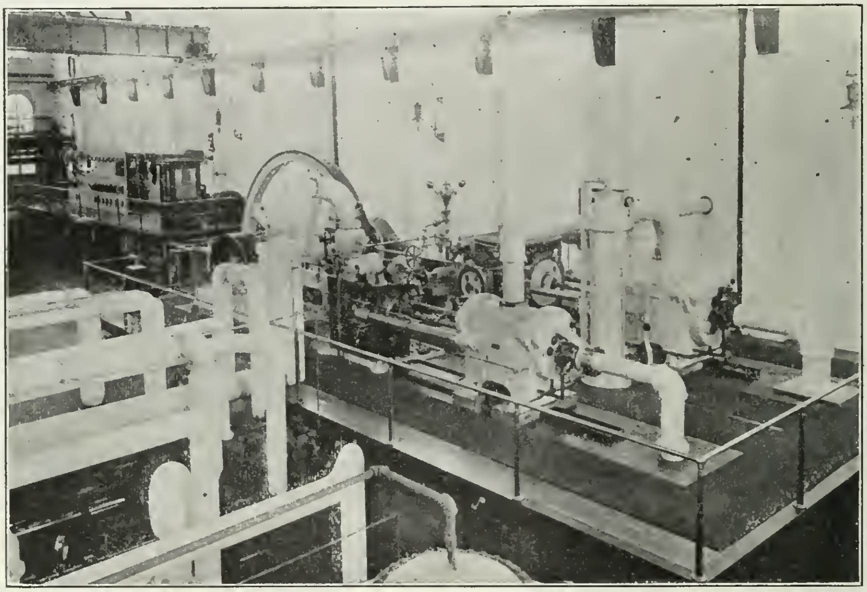
BORING LOGS.

In bleacheries and dye houses heavy maple logs are used for squeeze rolls, and the holes for the roll shafts must be bored straight and true. For this purpose the auger shaft is back-geared to a powerful pneumatic driller, both being attached to a special carriage on an old lathe bed. The log is carried on horses at the end of the bed, and the auger is fed through by hand. To drive a four inch "pod auger" through a ten foot log used to be a day's task for two men, the heart-breaking part of the task being due to the necessity for the frequent pulling out of the auger to clear the hole of chips. With the modern apparatus four ten foot logs are easily bored by one man, who requires no help except in the handling of the logs themselves to and from the machine.

All of the above uses of compressed air are for the mechanical force rather than for the manufacturing departments themselves; but we now come to the other ways in which compressed air is applied directly to the needs of manufacturing departments: namely, cleaning and humidifying.

CLEANING MACHINES.

For cleaning service typical cases show that the saving in labor and increase in production will pay from thirty to fifty per cent. per annum on the investment in the necessary plant. To cite a few examples:—tentering machines, stock dryers and other machines of this type, requiring ordinarily from one to two hours per week for cleaning, may be more thoroughly cleaned in fifteen or twenty minutes by the use of air nozzles than is possible by hand. Nappers, requiring half an hour's stoppage per day for hand cleaning, may be cleaned in from five to ten minutes per day by compressed air. Ring spinning, usually requiring from an hour to an hour and a half per week stoppage for cleaning, can be cleaned with compressed air with a stoppage of from twenty to thirty minutes per week—about two per cent. increase in production. In a room containing 50,000 ring spindles on No. 26's yarn, the number of hands engaged in cleaning and sweeping was reduced from fourteen to nine. In this

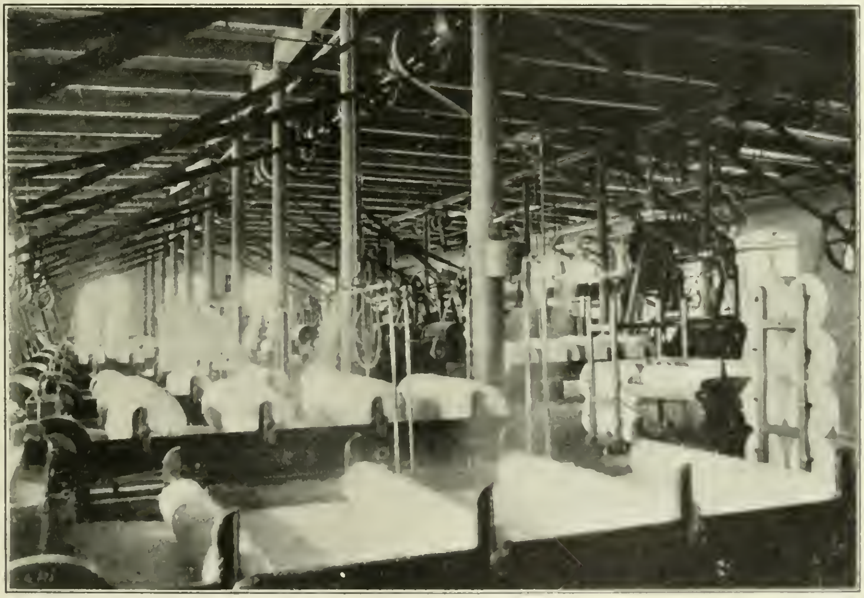


2,500 CUBIC FEET I. R. AIR COMPRESSOR AT AMOSKEAG MANUFACTURNIG CO.'S PLANT.

case alone the combined saving in cost of labor and value of increased production amounted to $1,700 per annum.

Pulleys, shafting and ceilings are also cleaned by air supplied through a light brass tube in a hollow wooden pole. Overhead cleaning must necessarily be done outside of regular working hours, or else the nearby frames must be stopped and afterwards dusted to prevent the lint brought down from overhead from getting into the work. Less stoppage, however, is necessary than when the overhead cleaning is done with brooms and brushes, as the work can be done in much less time and much more thoroughly.

Many manufacturers fear injury to the product from lint spun in while cleaning the frames, but as a matter of fact, the lint dislodged by the nozzle is so heavy that it settles at once to the floor if the operator uses ordinary care in keeping the point of the cleaning nozzle properly depressed. Of the many manufacturers who have tried air for this purpose, I have known none to abandon it.



MOISTENING BLEACHED AND COLORED COTTON LAPS ON FINISHER PICKERS
Turbo Head Above Second Lap from End of Lattice.

POWER COST OF THE AIR.

It may be of interest to state here that the nozzle used for this type of service has a small stop valve controlled by the thumb of the operator, and an extension of about fifteen inches of quarter-inch pipe reduced to a very small opening at the tip. This nozzle consumes from twelve to fifteen cubic feet of air per minute, which corresponds to less than two horsepower, and in the spinning room above mentioned, one nozzle is in practically constant use, and for about a quarter of the time three are in use. I draw particular attention to this as there is a prevalent misconception of the amount of power consumed in the use of compressed air. As the machinery of the above mentioned room requires over seven hundred horsepower, it is clear that the power required for cleaning, considered as a percentage of the whole, is negligible; and even when viewed as an actual expense at the annual cost per horsepower it seems equally unworthy of serious consideration.

A weaver will clean a loom in less than two minutes with a nozzle more thoroughly than in twenty minutes by hand, and this cleaning can be applied two or three times a week if desired, with resulting improvement in the product and no appreciable loss in production. Whenever the warp runs out the nozzle may be brought into play and all parts of the loom are then subjected to a still more thorough cleaning. It is also a fact that rooms cleaned by air will be found much freer from conditions inviting the starting and the spreading of fires—a statement which any insurance inspector will confirm without hesitation.

I have frequently been asked why no exhaust systems are used to take care of the lint dislodged by the air nozzle. This might, perhaps, be accomplished by providing a hopper under each machine, into which the dust could be swept, connected with permanent sheet metal exhaust pipes leading to fans and dust collectors, but so many objections to such a system, such as the multiplicity of pipes which would be required, and the necessity for their frequent cleaning, are at once apparent, that it may safely be condemned as impracticable. A portable dust collector or portable exhaust pipes, on the other hand, would seem equally undesirable, as it would be extremely difficult to move any such apparatus about in the narrow alleys between the machines.

Electric power has become a characteristic feature of all new textile plants of any considerable size and most progressive mills are replacing many of their older mechanical transmission system with either group or individual motor drives. For cleaning electrical machinery when exposed to the dust and the lint inseparable from textile mills, air cleaning is an essential rather than a convenience, and so widely is it used for this purpose that its mention here is perhaps superfluous.

HUMIDIFICATION.

The necessity for artificial humidification is to-day so widely recognized by textile manufacturers that practically every progressive mill has a humidifying equipment of some sort. A few old plants have nothing more than old-style "vapor pots," but most modern plants have an equipment of one of two classes of humidifiers which may be termed the local distribution type and the air conditioning type.

Each of these has its advocates, but local distribution is more generally used, and to this system compressed air is well adapted. Most humidfier systems use water under pressure, and are characterized by bulky metallic casings and systems of drain pipes leading to filter tanks or sewers, all of which require more or less head room, obstruct considerable light and require frequent cleaning. Compressed air humidifiers, on the other hand, require no drainage systems, as all the water delivered is completely evaporated. The water used is supplied by gravity from small tanks at the level of the supply pipes, which are provided with safety overflows, and the danger of damage to stock and machinery from overflow and leakage is thus obviated. The pipes, being small, occupy so little room that they can be installed in very low posted rooms without inconvenience. On account of the small quantity of water handled and the absence of dirt in the air supplied, there is practically no accumulation of dirt or sediment, and the heads require little or no attention for cleaning or repairs.

Air humidifiers can, moreover, be operated successfully under conditions impossible with other types. In napping rooms, for instance, any system depending on drainage will become so quickly clogged with dirt or lint as to practically prohibit its use. An air system, however, operates as easily there as elsewhere. One cut shown herewith illustrates another useful function of air humidifiers, namely stock moistening, for which a special head is used to produce a coarser spray than that produced by the standard humidifiers. These are of great use in carding colored and bleached cotton, and the cut referred to shows a row of finisher pickers on which the back laps are moistened by humidifiers.

In closing the writer wishes to speak particularly in regard to the only objection he has ever heard raised to the use of compressed air—the cost of the power required to generate it. The prevalent idea on this subject is very erroneous, possibly from the fact that the average manufacturer has attached undue importance to the horsepower rating of the compressor at its full load. It is of course necessary to install a compressor of capacity sufficient for the "peak load," plus a reasonable margin for possible extensions, but in practice the duty is so variable that the mean load will generally be only from one-half to three-quarters of the peak-load, and the cost of power consumed is of course proportional to the mean load only. Furthermore, the compressor can usually be located in engine or wheel rooms where no extra cost of attendance is entailed, and the power there only stands the manufacturer the fuel, water or electric expense.

Moreover, the relation between the cost of generating a few horsepowers and the cost of employing one unnecessary laborer or operative is often overlooked. *It costs on the average from ten to twenty times as much to employ one additional hand as it does to generate one extra horsepower.* Consequently, a compressed air plant costs very little to maintain when compared with the saving in labor which it effects.

After seven years experience with compressed air in mill work the writer is firmly convinced that the actual return on the investment in a compressed air plant well utilized is not less than twenty-five per cent. in a mill of any ordinary size, and in growing plants actively engaged in building and constructive work, it would often pay for itself in a year or less. Furthermore, the possession of this powerful auxiliary, always ready to cope with important tasks in emergency, constitutes an important asset whose value it is difficult to estimate, but which experience will prove to be by no means inconsiderable.

[For the half tones illustrating the above article we are indebted to the courtesy of the *Textile Manufacturer's Journal.*]

AIR LIFTS AT MEMPHIS

For the water supply of Memphis, Tenn., there is said to be the largest artesian well installation in the United States. The initial plant of the system consisted of wells 8 and 10 inches in diameter driven to an average depth of 500 feet, their combined flow being pumped into the city mains by three 10,000,000 gallon pumps. The limit of supply from this source was reached at about 20,000,000 gallons per day and the continued growth of the city made an increased supply necessary. In 1907 the Commission became convinced that the air lift wells were bored in the eastern part of the city, a larger one being added later. our acshould be employed, and accordingly five new count being taken from the *Municipal Journal and Engineer*, New York.

The power plant installed comprised: Five 150 horse power fire tube boilers; five cross-compound, two-stage Laidlaw-Dunn-Gordon compressors with a capacity of 500 cu. ft. of free air per minute each; five compound American Steam Pump Co. pumps of 1,000,000 gallons per day each, and one duplex compound Worthington pump of 2,000,000 gallons per day capacity, all the compressors and pumps being run condensing.

There are six wells averaging about half a mile apart. Nos. 1 and 6 are situated on the city's property, and after the water is brought to the surface by the air lifts it flows down grade into the collecting basin, but with the other wells the water after it is brought to the surface is forced up a grade of nine feet ½ to ¾ mile into the same collecting basin. All wells are 10 inches in diameter with 50 feet of 8 inch Cook strainer, except Well No. 6, which is 13 inches in diameter with 65 feet of 12 inch strainer. Independent 4 inch air lines are run to each well, with a 2½ inch line in all wells except No. 6, in which a 3 inch air line is used. The air lines are so cross-connected in the station that any compressor can be connected to any well.

Wells Nos. 2, 3, 4 and 5 are located in the streets 1,000, 2,000, 3,000 and 4,000 feet, respectively, from the plant, are all connected to our general collecting main, and all except No. 5 have been placed in service.

The railroad being on the highest ridge, and it being necessary to locate the plant along it on account of the coal question, the tops of the wells are from 7 to 18 feet below the discharge in the collecting basin. Moving water by air through a long pipe with a slight upgrade from the well is highly inefficient, it being undesirable also to place standpipes in the streets high enough to cause the water to flow by gravity to the collecting basin, the following plan was resorted to:

A steel tank 6 feet high and 8 feet in diameter was sunk below the surface of the street over the top of each well, the well casing extending into the tank to within 18 inches of the top. A connection to the collecting main was run from the bottom of the tank with a check valve in same. This also extends up into the tank as high as the well tube. Over this was suspended a longer pipe, extending from a few inches above the bottom of the tank to within six inches of the top. This causes the water to follow a tortuous passage and gives an additional chance to liberate the air.

From the top of the tank a 3-inch pipe was run to a vault under the sidewalk where it terminated in a specially designed valve so weighted as to allow the air to escape at about the pressure due to the head of the discharge in the collecting basin above the top of the well.

This arrangement has proven highly satisfactory, the water reaching the collecting basin entirely free from air. A much higher efficiency was found than when the air was forced along with the water.

Tests were made with 8-inch and 10-inch discharge pipes and the 10-inch finally was used. The following table shows the best results of these tests:

No of Well	Diam. of Discharge	Diam. of Air Line	Submersion of Air Line	Operating Pressure	Draft of Well	Total Lift	Gals. Water Per Min.	Cu. Ft. Free Air Per Min	Cu. Ft. Free Air Per Gal.
	Ins	Ins.	Ft	Lbs	Ft.	Ft			
1.	10	2½	65.2	60.0	18.5	73.9	974	336	0.345
2.	10	2½	63.2	57.5	13.9	77.2	883	332	0.376
3	10	2½	63.4	58.5	15.0	78.1	603	347	0.576
4	10	2½	66.1	57.5	17.3	68.9	701	307	0.437
6	13	3		73.0	41.6	120.6	1410	514	0.364

At the time the test of well No. 3 was made the well casing only extended into the trap 24 inches. This has since been raised and the flow very materially increased without an increase of the air supply. The flow of well no. 6 also has been increased to 1,750 gallons per minute, but no accurate tests made as to air per gallon.

Since the operation of this new plant has been so successful it is felt that the water question has been permanently settled, as it will only be necessary to erect plants similar to this in different sections of the city whenever the present supply is inadequate to fill the demands of its rapid growth.

The quality of the water is acknowledged to be as near perfection as that of any other public water. The only objection heretofore existing was that the iron in it would stain china or porcelain vessels; but since the operation of this new air lift plant this objectionable feature has disappeared, and the water forms no discoloration whatever, but is as clear as crystal after having been drawn several days.

A School of Mines is to be established at Illinois State University. It was asked for by a committee representing miners, operators, inspectors and manufacturers, and the General Assembly promptly voted the money. It is understood that the men will be especially trained to work in and investigate the problems of coal mining.

A PNEUMATIC OILING SYSTEM

By George L. Fales.

Herewith are an explanation and illustration of an oiling system which is not advanced as anything new or original, except that the oil is all practically handled by compressed air, instead of by gravity feed or direct pump pressure.

Such a system has the advantage that the new oil is being drawn from barrels and does not enter the power station at all, the barrels remaining outside of the building, as shown in Fig. 1. The vacuum in the oil tank is induced by the pipe running to a Conover independent condenser. There is no oil wasted nor spilled by this method. All filters, oil tanks, pumps, etc., are below the engine-room floor, where they can all be attended to by one attendant. There are no unsightly tanks on the wall of the engine-room.

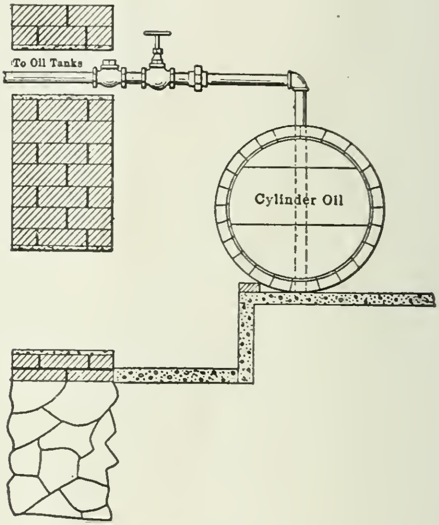


FIG. 1. BARRELS EMPTIED OUTSIDE THE BUILDING

This system consists of five tanks, Fig. 2, arranged in a row: the first four receive the waste oil drips from all the engines, which filter down through waste, and up through water in the bottom of the tank, flowing from the top of the water out into a header pipe common to the four filters, and discharging into a receptacle at the top of the tank *A*.

This tank has five ½-inch pipes, with valves attached, arranged around the circumference of the receptacle at the bottom, and discharging through these into five wire screen cylinders, closed at the bottom, and wrapped with toweling, through which all the oil filters.

These cylinders are set on a perforated plate into which space the oil drips from the cylinders, through the toweling, and then runs through the suction pipe of the oil pump, which enters the bottom of the tank, and it is then pumped to the filtered oil-storage and feed tanks by the electrically driven pump.

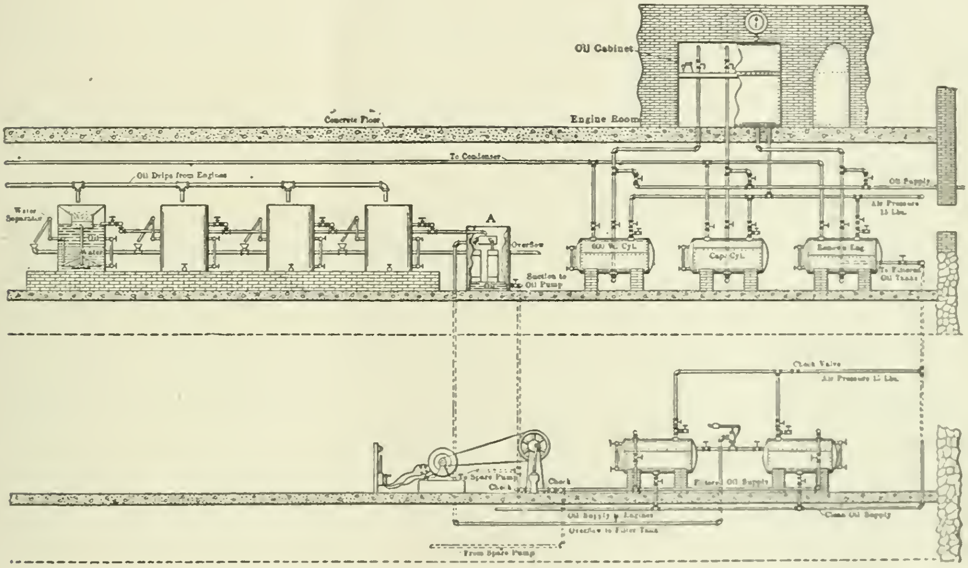


FIG. 2. VERTICAL SECTION SHOWING OILING SYSTEM.

These tanks have an air pressure of 15 pounds applied to the top of the oil. Enough oil is kept in the system to keep both tanks two-thirds full. An overflow pipe is attached to each tank two-thirds of the distance from the bottom, and these combine and discharge together through a safety valve into the filter tank *A*, as shown.

The pump is kept running continuously and if stopped for any cause, there is enough oil in the tanks to supply the engines for some three hours, the air pressure supplying the necessary pressure to feed the oil.

When the pump is stopped, either by the circuit-breaker coming out or for any other reason, the handle of the motor-starting rheostat, in going to the off position, throws into circuit a red light which is placed in the engine room, thereby giving notice that the pump is off. The lamp continues to burn until the motor is again started.

We also have a spare pump attached to the end of the main shaft on the Conover condenser, which can be used as a spare pump.

To make up the natural loss of oil, and to keep the system at the required level, there is a pipe branching from the feed line on the new oil tank, through which new oil may be introduced into the filtered oil tanks by simply opening one valve.

New engine oil and two kinds of cylinder oil are drawn into three tanks arranged as shown in Fig. 2. The oil is drawn from barrels outside of the engine room through a 1¼-inch pipe. The bungs are knocked out of the barrels and the pipe put in, the union made tight and a vacuum turned on. A barrel of engine oil will flow into the tank in about five minutes; cylinder oils take more time, depending on the temperature.

When there is sufficient oil in the tanks, as shown by the gages on the ends, the vacuum is shut off and an air pressure of 15 pounds is applied to the top of the oil and kept on at all times, except when filling the tanks.

Pipes from the bottom of the tanks lead

to the oil cabinet in the engine room, and oil is measured out to the oilers from this cabinet and a record kept of it.

New engine oil is used on valve gears and in blowing-engine cylinders, and to make up loss in the filtered-oil system; all other bearings are lubricated with filtered oil which is all returned to the filters from the drip pans of the engines.

A reducing valve on the high-pressure line reduces the pressure from 120 to 15 pounds. A safety valve is attached to the low-pressure line, in case the reducing valve should stick or leak.

The installation operates very satisfactorily, and is a great saver of time, patience and oil and is reliable.—*Power and the Engineer.*

AIR COOLING BY REFRIGERATION

The following is a brief extract from a valuable paper by W. W. Macon before the American Society of Heating and Ventilating Engineers:

GREATER HEAT TRANSFERS IN COOLING THAN IN HEATING AIR.

Air cooling is seldom merely a case of air warming reversed. In air warming the vapor present is heated along with the air, but it has so little weight in comparison with the air that it is neglected in heating calculations. In air cooling, however, portions of the vapor must be extracted step by step, and this process requires the absorption of the heat of vaporization necessary to reduce the vapor to water. The heat of vaporization is relatively so large that the total heat involved in cooling air may be two or three times as much as that involved in warming the same amount of air through an equal range of temperature. In air cooling, therefore, humidity is an important consideration.

Heating 43.35 pounds of saturated air at ordinary atmospheric pressure from 82 degrees to 83 degrees F. means heating 42.35 pounds of dry air and one pound of water in the form of vapor. Taking the specific heat of air at 0.238, and assuming that the specific heat of the vapor is the same as for water, or unity, the addition of heat involved is $0.238 \times 42.35 + 1 = 11.08$ B. T. U. Cooling the same weight of saturated air from 82 degrees to 81 degrees F. means a subtraction of heat of approximately $0.238 \times 42.35 + 0.026 \times 1{,}050 = 10.08 + 27.3 = 37.38$ B. T. U.; 0.026 being the weight, in a fraction of a pound, of the vapor condensed in the one-degree drop, and 1,050 being approximately the latent heat of vaporization, or the heat corresponding to that effecting the change of state from liquid to gas or vice versa. It will be noted that over twice as much heat has to be extracted for liquefying the vapor as for cooling the air itself, and this explains the important difference between air cooling and air heating, and why it is so much more expensive to cool air than to warm it. Cooling air without bringing about the saturated condition is of course no different from air warming, but an air cooling problem would always carry the conditions beyond this limitation.

HEAT EXCHANGES IN COOLING A ROOM.

To maintain a room, as in summer, at a temperature below that outdoors means that a flow of heat will occur from the outside to the inside. The supply of heat from this source will be augmented by that given out by the people present and by the lights burned. To keep down the temperature is the work of the air supply, which must be in sufficient quantity and sufficiently below the desired room temperature to absorb the heat supply without exceeding the room temperature before escaping. The refrigerating plant must then be chosen of a capacity equal to cooling the calculated volume of air from the outside temperature to a temperature low enough to take into account the warming up which the air may get before reaching the room. Some of the limiting considerations are that the volume of air must not be so great as to cause draftiness, nor must the individual be directly exposed to air currents at low temperature.

Assume that a room is to be at 75 degrees F. when it is 90 degrees outdoors. The transmission of heat through the exposed walls for the 15 degrees range will be about 15-70, or 3-14, of what the transmission is at 70 degrees range, and it might figure that the average flow of heat through the walls is 8 B. T. U. per hour for square foot of the average exposed wall surface. If there is a large area of glass surface including skylights, through which the sun's rays can penetrate, account must also be taken of this source of heat, regarding it, for example, as equivalent to adding two to five degrees to the outside temperature.

HEAT RADIATION OF THE HUMAN BODY.

That the animal heat from the individual is something of importance can be apprehended from the fact that the average individual will give off probably 400 heat units per hour. If the character of the walls and the relation of the actual glass surface to the total wall surface is such that the average transmission per square foot of the wall surface is about 8 B. T. U. per hour, it will be seen that each individual in the room is equivalent to an additional fifty square feet of exposed wall surface. In other words, if a relatively large number of people is to be accommodated in the room, the heat supplied from the human beings will be considerably greater than that coming in from the external sources.

Having ascertained the total amount of heat which will be supplied to the room interior under the extreme requirements for which the installation is to be designed, a measure is then had of determining the probable volume of air which should be admitted. This, of course, depends on the number of degrees through which the air is to be allowed to warm from the time it enters the room to the time it passes away. The determination of the proper number of cubic feet of air in a given time is a matter of arithmetic—the greater the range of temperature the less the volume. If a room is to be maintained at 75 degrees F. and the air by which this is to be effected is to be allowed to warm, say, ten degrees, it is obvious that the air must enter the room at a temperature approximating 65 degrees F. As there will be an unavoidable rise in the temperature of the air in its transit from the air-cooling coils and the fan to the room inlets, the actual temperature to which the air must be reduced by the refrigerating installation must be below 65 degrees F. Allowing five degrees on this account means that the air should be cooled by the refrigerating plant to about 60 degrees F.

St. Louis is about to begin the building of a free bridge across the Mississippi, bids being asked for for the substructure work. The bridge will have main spans of 2000 feet, and the cost of the bridge and approaches is estimated at $3.200,000.

COMPRESSED AIR LOCOMOTIVES IN GERMAN COAL MINES

The circumstance that the compressed air locomotive has become a favorite method of traction in the workings of American collieries has induced one of the large Westphalian coal mining companies, the Colner Bergwerks Verein, to make an experimental trial of the method in their Emscher pits for a district of workings where the strata are much disturbed, and consequently incapable of a very large daily output. The haulage to be done is equivalent to about 250 ton-miles in the shift of eight hours, the coal being got from four working places distant 1539, 765, 765 and 875 yards from the pit bottom respectively. The motive power, compressed air, is furnished by a two-stage compressor driven by a direct-current electro-motor of 85 horse-power, which, at 200 revolutions, supplies 159 cubic feet of free air per minute at 1500 lb. above the atmospheric pressure. The air so compressed passes through an equalizing reservoir of 35 cubic feet capacity and down the shaft to the main haulage road 299 yards below the surface by a line of 1½ in. wrought iron pipes, three other reservoirs of 35 cubic feet each being intercalated in the line at equal distances apart in the levels underground, to serve as filling places for the locomotives, which are supplied through reducing valves at 750 lb. pressure. The principal feature of the locomotive is the main air reservoir, a cylindrical vessel 10 ft. 4 in. long and 33½ in. diameter, of 57 cubic feet capacity, corresponding to 2910 ft. of free air compressed to the working pressure of 50 atmospheres. Below the main air vessel a smaller one is placed, with a reducing valve connection which brings the pressure down to 10 atmospheres, the initial admission pressure in the cylinders. The air vessels and the engine cylinders are carried by longitudinal cast iron framings mounted on a pair of coupled wheels of 19½ in. diameter, and a wheel base of 39.2 in. The total weight in running order is 5 to 6 tons. Under normal working conditions the power developed ranges from 8 horse-power to 12 horse-power, with a maximum of 24 horse-power, and the hauling capacity is forty to fifty laden coal tubs of 2180 lb. gross, or 1245 lb. net weight, each moved on an incline of 1 in 300 at 8.2 ft. per second—5.6 miles per hour. With two locomotives at work, hauling from the four different working places, the work done in the shift corresponded to 262 ton-miles, the actual running times for the two engines being 313 min., while 642 min. were accounted for in stoppages and shunting work. The work done by the compressor during its 400 min. of running time corresponded to 374 kilowatt-hours. Under these conditions the total cost of haulage per useful ton-kilometre was 8.59 pf., equal to about 3.5 cents per ton-mile. The annual operating cost, including the outlay for power, wages, repairs, lubricating and cleaning materials, interest and sinking fund on the cost of the plant, amounts to $8,750.

During a trial extending over seven months the work has been carried on continuously without any interruption of the regular work, as even on one occasion, when the compressor was stopped for twelve hours to replace a defective valve, the engines ran to the end of the shift with the supply contained, while the main has also remained wonderfully tight; the supply reservoir, when filled at 100 atmospheres at 2 p. m. one day, showed a gauge pressure of 93 atmospheres at 5.30 a. m. on the following morning. [This shrinkage may have been largely due to the cooling of the air. Ed. C. A. M.] The general results of the trials may, therefore, be considered as satisfactory, as, although, like all compressed air machinery, the mechanical efficiency is somewhat low, and the first cost of the primary power arrangements is decidedly higher than that called for by electric locomotives, the working cost, including wear and tear and maintenance, is considerbaly lower.

The general idea that marsh gas, so common in coal seams, accumulates and remains in cavities in the roof and higher places of a coal bed, is considerably in error. It is true that this gas is lighter than air, and that as a consequence its presence may sometimes be first noticed in such cavities and high places; however, the accumulation of marsh gas in such places will be only temporary. From the moment the gas is liberated, it is largely governed by the natural law known as "the diffusion of gases," and it immediately begins to mix with the mine atmosphere until it is distributed all through it.

CAISSON DISEASE AND ITS PREVENTION*

BY HENRY JAPP, M. AM. SOC. C. E.

The prevention of caisson disease has not received as much attention as its cure, the general opinion being that it cannot be prevented. In forming an idea as to the possibility of its prevention, something may be learned from Nature's method of carrying out work by the aid of living organisms under air pressure.

First let us inquire whether Nature has a sufficient range of air pressure to make it necessary for a capacity to sustain variations without injury. The highest altitude on this earth is Mount Everest, 29,000 ft. above the level of the sea, and the deepest mine is Tamarack No. 3 Shaft, of the Calumet and Hecla Mines, 4,407 ft. below sea level.

The curve on Fig. 1 shows the absolute air pressure at various altitudes between these extremes. The total difference of 12½ lbs. per sq. in., or from 9¾ lbs. below atmospheric pressure at sea level (viz., 14.7 lbs.) up to 2¾ lbs. above normal, is considerable.

Mount Everest has never been ascended, but an elevation of 20,000 ft. has been reached, and men can live in comfort at an altitude of 7,000 ft., as in Mexico City, which has an air pressure of 3½ lbs. per sq. in. less than at the coast. Such a change of pressure is quite noticeable to those whose Eustachian tubes are closed, and, although the range of pressure is insufficient to produce caisson disease, yet travelers have complained of discomfort, not unlike a very mild attack, after a rapid journey by rail from Vera Cruz to Mexico City.

Eagles are known to go to great heights beyond the range of human vision, fish are capable of going to great depths in water, and beasts of prey roam from the mountain side to the valleys far below. With each descent these creature have undergone compression, and with each ascent decompression.

It will be noted that Nature has no time limit for immersion under increased pressure, and the application of pressure is a much speedier and easier operation than that of decompression; and, while the compression is down-hill and attained with little effort, the decompression can only be attained by the continuous effort of climbing, and, in long ascents, with frequent rests, or by stages. This is surely a forecast of the stage-decompression theory.

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*Proceedings of the American Society of Civil Engineers, April, 1909. Abridged.

From Nature, then, our best teacher, we learn that the time taken to enter the air-chamber may be short, the time spent in the air-chamber may be long, and the rate of coming out must be slow and accompanied by exercise.

In early compressed-air work engineers were confronted with caisson disease, and have long been striving for a remedy. Men of observation noted first that lock tenders who made frequent entry to the air-lock for short visits were much more immune from the malady than workers who stayed for a full shift, and from this argued that shortening the time in the air-chamber would be a safeguard, and, as higher pressures were used, the hours continued to be shortened until it was thought that half an hour at a maximum of 50 lbs. gage pressure was the limit of human endurance.

As the number of compressed-air workers increased, so the workmen gained in experience it was noted that workmen who suffered from the painful forms of caisson disease relieved the pain by re-entering the air-chamber.

About 30 years ago Paul Bert advanced the theory that caisson disease was caused by the nitrogen of the air being dissolved in the blood. He advocated slow decompression, suggesting 30 mins. for 2 to 3 atmospheres (15 to 30 lbs. gage pressure) and 60 mins. for 3 to 4 atmospheres. Since his time many writers and experimenters have followed in his footsteps, but it was not until Dr. Smith, of New York, suggested that a recompression chamber would act as a remedy, and E. W. Moir, M. Am. Soc. C. E., of London, without knowledge of Dr. Smith's prior suggestion, actually built a medical air-lock, or recompression chamber, in 1890, on the old Hudson Tunnel, New York, that any reliable cure for the trouble was discovered. Figure 2 shows the medical air-lock designed by Mr. Moir, of which six were used on the East River tunnels of the Pennsylvania Tunnel & Terminal R. R.

It was then found that if a man suffering from caisson disease in any of its many forms, varying from unconsciousness and paralysis to an acute pain in the limbs, was quickly recompressed and allowed to decompress slowly, in many cases a cure resulted, but not always.

This went to prove that the disease was a mechanical one, and was caused by the dissolved air in the blood and tissues becoming liberated in the body in the form of expanding bubbles which tore the tissues, caused pressure on the brain, injured the spinal cord, or frothed up the blood and stopped the circulation or heart action.

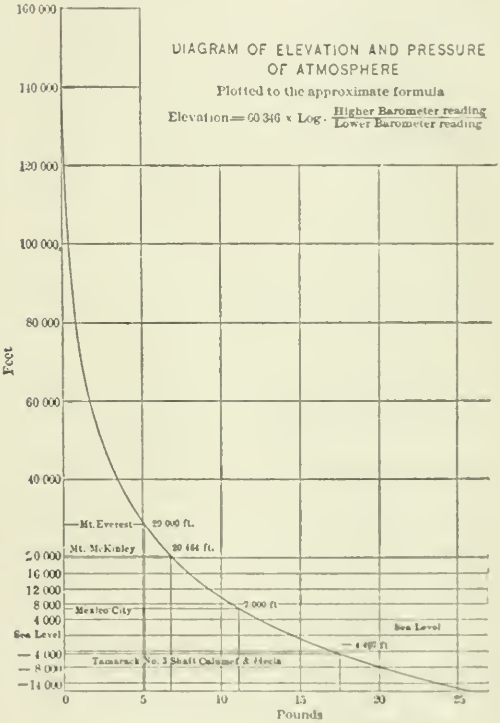

FIG. 1.

Much has been done since the introduction of the medical air-lock. The percentage of carbon dioxide in the air of the working chamber has been kept within safe limits, moisture and oil have been extracted from the air before delivery to the chamber, and the workmen have been well cared for, but still caisson disease claims its victims, and engineers consider this inevitable.

The erratic manner of the disease puzzles doctors and engineers alike. Men who have worked for months in high pressures for the regulation shift without suffering have been suddenly attacked and died; others, working only half a shift, have been paralyzed; while exceptions have worked for 12 hours at a time and have suffered only slight pains which have quickly passed away.

The writer, as Managing Engineer for S. Pearson & Son, Inc., on the East River tunnels contract for the Pennsylvania Tunnel & Terminal R. R. Co., New York, with as many as ten tunnel headings under compressed air simultaneously, has had many opportunities of studying this strange disease.

When these tunnels were commenced, in 1904, the knowledge of compressed air at the disposal of the contractor was quite extensive, and included the long experience of Alfred Noble, Past-President, Am. Soc. C. E., on caisson work in the United States, and Mr. E. W. Moir's experience on the Forth Bridge caissons, the old Hudson Tunnel, and the Blackwall caissons and tunnel.

In the light of past experience, the general conduct of the work was framed on a few established rules which when condensed amount to the following: No workman was allowed to enter the air-chamber without a physical examination by the qualified medical officer of the contractors. Sound physique was the chief requirement. The men were cautioned not to enter the air on an empty stomach, to wear warm clothing on coming out, and to drink hot coffee.

The time worked in the air-chamber was limited to 8 hours with half an hour off for lunch, up to 32 lbs. gage pressure, and two spells of 3 hours each with 3 hours rest between for pressures from 32 to 42 lbs. and two spells of 2 hours each for pressures greater than 42 lbs. with 4 hours rest between, with no limitation as to decompression. Two medical air-locks were installed on each side of the river, well-warmed dressing rooms were provided for the workmen, and there were covered gangways for access to the shafts.

The air was cooled before delivery to the tunnels, and samples were taken in the tunnels by Mr. Noble's engineers and analyzed daily. The air was regulated so that the carbon dioxide did not exceed 10 parts in 10,000, and the tunnels were kept in a sanitary condition.

Owing to the grade of the tunnels being so deep on the Manhattan side of the river, the air pressure very quickly rose to 36 lbs.

Practically no cases of bends occurred until the pressure reached 29 lbs. and then, within a few days of each other, two men died. These men had entered the air-chamber without being passed by the doctor. Then it became necessary to post outside each air-chamber a guard whose duty it was to keep out of the tunnel men who had no doctor's pass. At this time, reliance could not be placed on the tunnel foremen, as they were likely to be absent from work, and new men had to be selected each day.

For many months after the work started, while the men were being seasoned, the tunnel gangs and foremen were in a state of change, owing to the difficulty of getting good men and the frequent absences due to caisson disease, and it was a long time before an efficient organization was built up.

As the tunnels were driven deeper beneath the East River the pressure quickly rose, and ultimately reached 36 lbs. gage pressure, with only one set of air-locks in operation; but even the change at 32 lbs. from one shift of 8 hours to two shifts of 3 hours each gave no relief, and cases of bends, sometimes fatal, continued all the time.

It was not long after 27 lbs. was reached that the more sensitive members of the staff found that it did not pay to come out quickly, and at 30 lbs. pressure it became a custom to take about ½ min. for each pound. After one or two additional fatal cases occurred, it was decided to limit the workmen to approximately the same rate of decompression, or actually 15 mins. for 35 lbs. pressure.

Many of the men complained that taking so long to decompress gave them caisson disease, and it was difficult to compel them to take long enough. The guards at the entrance to the tunnels had now to record the time taken to decompress, and, as the workmen frequently used the lower muck locks as well as the upper man lock, it was impossible to tell when the decompression commenced owing to the noise of exhausting air. Therefore it became necessary to run a small ¼-in. pipe from the exhaust pipe of each lock to the cabin in which the guard was stationed, a whistle was attached, and a small ball of cotton was suspended by a light string over each pipe. The clerk, noting when the ball was puffed off for each lock, booked the workmen off as they left the lock. The material locks were fitted with inner material valves and, in addition, man valves of smaller size, and a pressure gage and a clock were fixed in each air-lock.

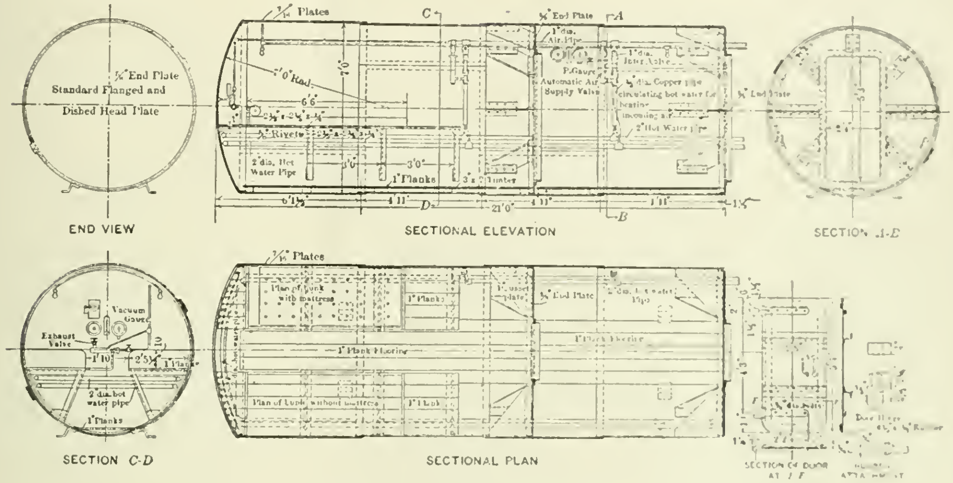

FIG. 2. MEDICAL AIR LOCK.

As the guard had already booked the men as they entered, he could tell if any were exceeding the regular working shift, and his record was valuable for checking the timekeepers. This rough method of checking the duration of the decompression was quite enough for the purpose. An attempt to improve it was made when a 12-in. Crosby recording gage was installed on one air-lock, but it was ineffectual because the air-lock was often sent out or decompressed with no one inside, and this complicated the record, which was much too small, and involved considerable trouble in locating the record of decompression for individual gangs. No doubt a suitable recording instrument could be devised for this special purpose.

The effect of lengthening the decompression period to 15 mins. reduced the number of cases of bends, and no doubt prevented many fatal ones, but they still occurred. As the tunnels had many months to run at high air pressures, the question was: What else can be done to prevent them?

The writer, on coming out of the tunnel with the workmen, observed that the rate of decompressing was most irregular. One lock tender would allow the air to escape slowly until the 15 mins. was almost exhausted, and then, by opening the valve, would let off the remaining pressure very quickly. Others would reverse the process, and exhaust quickly, and then keep the men under 2 or 3 lbs. until the time expired. To avoid this, a simple decompressing valve was designed which gave a uniform decompression from 35 lbs. to atmosphere in 15 mins. A somewhat similar one was designed for the medical air-lock, for 1 hour decompression for 35 lbs. with an automatic ventilator attached.

These valves certainly improved conditions, but still fatal cases occurred. After the first valve was under operation, the writer's attention was called to "Modern Tunnel Practice," by D. McN. Stauffer, M. Am. Soc. C. E., wherein a description is given of a needle decompression valve used on the air-locks at the Kiel Dry Dock Works, in Germany. A similar valve was also used for compression. On entering the lock the air was admitted at the rate of 1.5 lbs. per min., and was decompressed at the rate of ¾ lb. per min., or, for 35 lbs. gage pressure, 23 mins. for entering the air and 46 mins. for leaving. This needle valve was often frozen up, but otherwise worked well.

Such speeds seemed altogether too slow, and Mr. Stauffer in his book states that "these rates would be deemed excessively slow in American caisson practice." No date is given for the Kiel Dry Dock work, but presumably it was under way in 1904.

It was not thought advisable to increase the time of decompression at that time, but preliminary tests under air pressure in the tunnels for 1½ hours were then tried for green men, followed by a second medical examination after decompressing in 15 mins. A few men were eliminated by this test, and one case of permanent paralysis resulted from the test in 34 lbs. gage pressure. Fresh starters were made to stay in the tunnel for one-quarter of a shift for the first half, and if no caisson disease followed they were allowed to work for the second half. This proved a good safeguard.

On Nov. 8, 1906, a second bulkhead was put in operation in one of the tunnels, and the pressure between the two bulkheads was reduced to 15 lbs. gage. The number of cases of disease was very small for that tunnel, and as soon as possible additional bulkheads were placed in all four tunnels. The result was to have been expected from the experience in other tunnels where two bulkheads were used; the exercise of the long walk between bulkheads, at low pressure, seemed to assist in driving off the bubbles of air from the blood.

The workmen were allowed to decompress from 35 to 15 lbs. as quickly as they pleased. They then walked for 500 ft. along the tunnel under 15 lbs. taking at least 5 mins. and then decompressed from 15 lbs. to atmosphere in 10 mins. so that in all about 16 mins. were occupied in decompressing. When the inner pressure was less than 32 lbs. an 8-hour shift was worked, with ½-hour interval for lunch, between bulkheads in low air pressure.

Just when it looked as if the double bulkheads with stage decompression had eliminated fatal and severe cases of caisson disease, two deaths occurred in physically perfect subjects.

In order to discover, if possible, the connection between the cases of disease and other things, charts were plotted by the medical staff for some months, showing the rise and fall of air pressure, hours worked, humidity, temperature, percentage of carbon dioxide, and number of green men in the tunnel, along with barometer readings, condition of weather, direction of wind, and number of cases of bends. The results were not very encouraging, but it was noted that the number of green men, the height of pressure in the tunnel and the number of cases of bends varied together.

The percentage of cases in air pressure of 31½ lbs. for 8-hour shifts was no more than the percentage in 32½ lbs. for two 3-hour shifts—in fact, it was, if anything, less for the longer shift. The decrease in length of shift added one extra gang of men, and probably many of these men being green accounted for this.

In November, 1906, Mr. Moir became acquainted in part with Dr. Haldane's work of investigation for the British Admiralty on "Deep Sea Diving," and ordered the decompressing valves changed so that the decompression was accelerated at the commencement of the operation, and slowed off toward the end. In October, 1906, the writer, endeavoring to find out the effect of sudden decompression, fitted an ordinary glass siphon bottle with a valve and pressure gage. This bottle was partly filled with water, and put under 36 lbs. air pressure for 12 hours. On suddenly releasing the pressure, no effervescence whatever took place, and only a very few minute bubbles were visible. The same thing was tried with the bottle partly filled with bullock's blood, with like results. Arguing that the placid surface of blood in a stationary vessel offered no such opportunity for dissolving air as occurs in the lung surface with the blood circulating, the siphon was again charged with 36 lbs. pressure, but was rotated for 24 hours under this pressure. The same result as before was observed on suddenly releasing the pressure; but, on closing the valve, the pressure recorded on the gage was about 1 lb. per sq. in. in less than 1 hour, and in 6 days a pressure of 13 lbs. was recorded, showing that the air dissolved in the blood came off very slowly.

If the cork of a bottle of aerated water is drawn quickly, it effervesces so violently that the water froths out of the neck of the bottle; but, if the gas is allowed to escape slowly, only a mild bubbling results. This in general is the theory on which slow decompression has been advocated in the past. The violence of the escape of carbon dioxide gas from aerated water, as compared with the escape of air from water released from pressure, is due to the greater solubility of carbon dioxide than air.

It was difficult to know what else could be done at this time in the way of eliminating caisson disease on the East River tunnels, and the cases of disease were certainly less frequent and less severe, although at long intervals fatal cases still occurred. The workmen, by this time, had become seasoned, and more seasoned men were now available from other works.

Dr. Leonard Hill read a paper on deep sea diving and caisson work, on Sept. 26, 1907, and exhibited the web of a living frog under a pressure of 20 atmospheres. On suddenly decompressing, bubbles were plainly visible in the blood vessels, multiplying quickly as they traveled along until the circulation was choked; on recompression the bubbles disappeared and circulation was resumed. He stated that he and Mr Greenwood had been under an air pressure of 92 lbs. and had suffered no ill effects.

Dr J. S. Haldane, on Nov. 20, 1907, read a most enlightening paper before the Society of Arts, in London, in which he gave the results of his investigation for the British Admiralty on "Deep Sea Diving." [See Compressed Air Mag., Dec., 1908. Page 5106, *et seq.*]

Dr. Haldane experimented with men and goats at high air pressures, with varying lengths of stay under air pressure, and with different speeds of decompression. From these he concluded that certain parts of the body, where the circulation is rapid and the number of blood vessels high for the mass of the part supplied, would be half saturated or desaturated in 5 mins., while other parts, with slight circulation for the mass, would require 75 mins. for 50 per cent. saturation, especially the fatty parts, as fat is found to dissolve about six times as much nitrogen as blood.

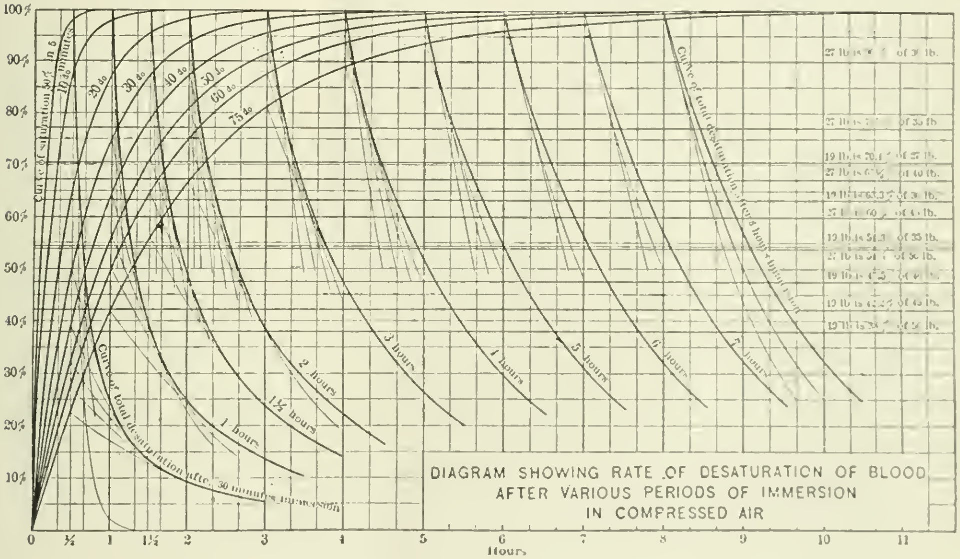

DIAGRAM SHOWING RATE OF DESATURATION OF BLOOD AFTER VARIOUS PERIODS OF IMMERSION IN COMPRESSED AIR

FIG. 3.

Figure 3 shows the rate of saturation, on the basis of half saturation in various times from 5 to 75 mins. and curves of desaturation, if the decompression is instantaneous after varying times of immersion from ½ hour up to 8 hours.

It will be seen that 90 per cent. saturation takes place in the slowest parts of the body in about 4 hours, and complete saturation for the quickest parts in about 40 mins., so that after 40 mins. immersion there is danger in too rapid decompression.

Dr Haldane has noted that no serious cases of caisson disease have occurred for rapid decompression at a working pressure of 19 lbs. gage pressure, or 2.3 atmospheres, absolute. Therefore, he concludes that it is always safe to decompress rapidly to half the absolute pressure, or even to the absolute pressure divided by 2.3, without bubbles being liberated. Further, if the decompression for the remaining pressure is continued at such a rate as will keep pace with the rate of desaturation, then, the absolute pressure of nitrogen in the blood never exceeding 2.3 times the absolute pressure in the air-lock during decompression or after returning to the atmosphere, no symptoms will occur.

TABLE I.—Dr. Haldane's Rate of Decompression in Caisson and Tunnel Works.

Working pressure in pounds per sq. in.	Number of minutes for each period of decompression after the first rapid stage.		
	After first 3 hours' exposure	After second or third 3 hours' exposure, showing an interval for a meal..........	After 6 hours or more of continuous exposure ....
18-20	2	3	5
21-24	3	5	7
25-29	5	7	8
30-34	6	7	9
35-39	7	8	9
40-45	7	8	9

Table I shows the rates of decompression advocated by Mr. Haldane for caisson workers:

If the pressure is 40 lbs. gage, decompress rapidly from 40 lb. to $\frac{40 + 15}{2} = 27\frac{1}{2}$ lbs. absolute, or 12½ lbs. gage, in 3 mins. and then take 7 mins. for each remaining pound, viz., 12½ lbs. or 87½ mins. plus 3 mins. = 90½ mins. or 1½ hours in all for a 3-hour immersion; or, for a 6-hour immersion, 115 mins. in all. The upper diagram on Fig. 4 shows this graphically.

It will be seen that, if this rule is followed, the condition of the absolute pressure, being half the pressure in the blood, is obtained. If uniform decompression for the same time were adopted, the decompression would be too slow for the earlier part, would very much retard the desaturation, and would give a greater tension in the blood than 19 lbs. on coming out of the air pressure.

It is obvious that while the air-lock has any pressure in it the desaturation takes place only in relation to that pressure, and, if one adopts Dr. Haldane's idea of keeping a portion of the tunnel at half the absolute pressure for a dressing room to act as a purgatorial chamber, where the men may wash and change while desaturating down to 19 lbs. we must make a new curve for desaturation and increase the time of decompressing, as will be seen by the second diagram on Fig. 4.

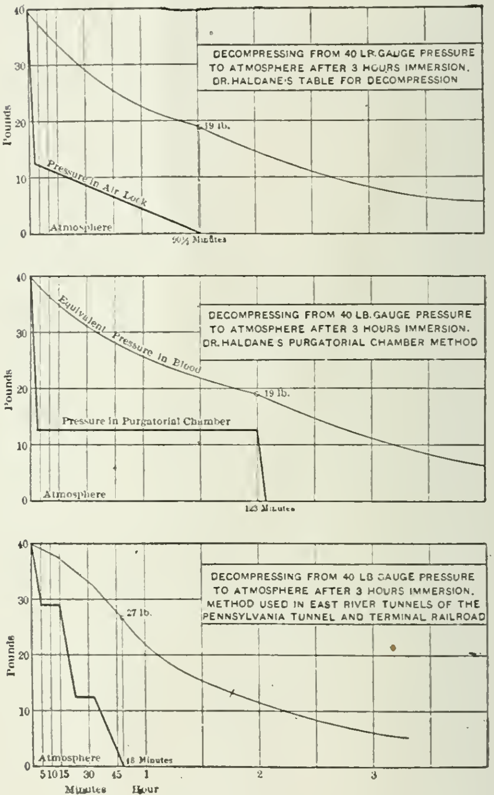

FIG. 4.

From this it appears that the tension in the blood does not reach 19 lbs. until a period of 123 mins. has been passed in the purgatorial chamber after 3 hours' immersion.

It will be noticed that Dr. Haldane bases his theory of decompression on the fact that no cases of caisson disease are chronicled for men working in gage pressures up to 19 lbs., or 34 lbs. absolute, and if it is safe to decompress suddenly from 34 lbs. absolute, to 15 lbs. absolute, it is safe to decompress suddenly from 50 lbs. absolute, to 22 lbs. absolute, or from 35 lbs. gage pressure, to 7 lbs. gage pressure.

The question arises at once: Are the times suggested by Dr. Haldane practical?

Many caissons of small dimensions are sunk under air pressures of 35 lbs. and to cramp men in a small air-lock for 73 mins. is out of the question, and the fitting of large compartments in small vertical air-locks, as used in building foundations in New York City, would be difficult. In tunnel work it would be easier, but the present method of rapid decompression is so radically different from Dr. Haldane's suggestion that it quite appals one to think of taking so long.

The experience of most compressed-air works is that up to 27 lbs. gage pressure there is very little trouble, and using this as the safe limit the times required to reduce the saturation in the blood to 27 lbs. is not so excessive for pressures up to 50 lbs.

The horizontal lines on Fig. 3 show the equivalent points for 27 and 19 lbs. in the blood for 50, 45, 40, 35, 30, and 27 lbs. gage pressure.

It will be noticed that the slowly saturated parts of the body are only partly saturated in the first few hours of immersion, and therefore the desaturation is proportionately fast.

TABLE II.—Times (in minutes) required for pressure in blood to fall to the equivalent of 19 lbs. gage pressure with instant decompression after various periods of immersion in compressed air.

No. of hours of immersion.	Gage Pressures. 27 lb. Minutes.	30 lb. Minutes.	35 lb. Minutes.	40 lb. Minutes.	45 lb. Minutes.	50 lb. Minutes.
½ hour....	4	5	8	10	14	16½
1 hour.....	7	10	15	20	26	32
1½ hours..	10	16	24	32	40	48
2 hours....	14	21	32	42	52	62
3 hours....	22	30	45	59	72	82
4 hours....	28	39	56	69	82	93
5 hours....	33	44	60	74	86	98
6 hours....	35	47	63	76	89	100
7 hours....	37	48	64	78	90	102
8 hours....	38	50	66	79	92	103

(The times in Table 2, being for instant decompression, must be suitably extended for slow decompression.)

From Fig. 3, Tables II and III have been compiled; they show the risks taken in rapid decompression after long immersion.

If the decompression is slow, these curves will be flattened out, and a longer time will elapse before the saturation of the blood falls to the equivalent of 19 lbs. or 27 lbs., as the case may be.

TABLE III.—Times (in minutes) required for pressure in blood to fall to the equivalent of 27 lbs. gage pressure with instant decompression after various periods of immersion in compressed air.

No. of hours of immersion.	Gage Pressure. 27 lb. Minutes.	30 lb. Minutes.	35 lb. Minutes.	40 lb. Minutes.	45 lb. Minutes.	50 lb. Minutes.
½ hour.... ..		1	3	4	6	8
1 hour..... ..		1½	5	8	12	16
1½ hours.. ...		2	6	12	18	24
2 hours.... ..		3	9	17	25	32
3 hours.... ..		5	15	25	34	45
4 hours.... ..		6	19	32	45	57
5 hours.... ..		8	22	37	50	61
6 hours.... ..		9	25	40	52	64
7 hours.... ..		10	27	41	54	65
8 hours.... ..		11	28	43	55	66

(The times in Table 3, being for instant decompression, must be suitably extended for slow decompression.)

Figure 5 shows the curves of decompression from 27, 30 and 32 lbs. gage, after 8 hours' immersion, and for 32, 35, 40, and 42 lbs. gage, after 3 hours' immersion, and 42, 45, and 50 lbs. gage, after 2 hours' immersion, on the basis that it is safe to decompress from 27 lbs. gage pressure, in 9 mins. This reduces the saturation in the blood to the equivalent of 25 lbs. on reaching atmospheric pressure.

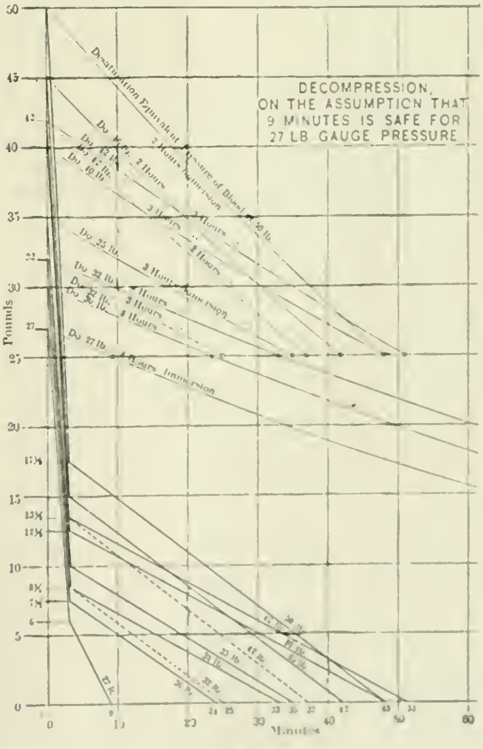

FIG. 5.

TABLE IV.—Decompression table based on 3 minutes being safe for 27 lbs. gage pressure.

Gage pressure in lbs.	Reduce pressure in 3 minutes to	Total time in airlock after 8 hours' work	Total time in airlock after 3 hours' work	Total time in airlock after 2 hours' work
27	6 lbs.	9	..	..
30	7½ lbs.	24	..	..
32	8½ lbs.	33	25	..
35	10 lbs.	..	35	..
40	12½ lbs.	..	48	..
42	13½ lbs.	..	51	37
45	15 lbs.	..	..	42
50	17½ lbs.	..	..	48

Table IV is taken from Fig. 5. and in part is confirmed by the experience in the East River tunnels as comparatively safe. Caisson disease will result, but no fatal or severe case should be experienced with physically sound men if these times are adhered to.

Some time after reading Dr. Haldane's paper and studying his theory, it became necessary to raise the pressure in the tunnels to 40 lbs. gage. It was possible to make the workmen pass through three sets of air-locks on leaving the tunnel. The inner chamber was kept at 40 lbs., the intermediate chamber at 29 lbs., and the outer chamber at 12½ lbs.

The men were ordered to take 5 mins. in the first lock, 8 mins. in the second lock, and 15 mins. in the third. There was a distance of approximately 1,000 ft. between each pair of locks. Walking this distance and gathering in the stragglers generally required 10 mins. to each chamber, so that, in all, 48 mins. were taken to decompress from 40 lbs. to atmosphere. No severe or fatal cases resulted, and little time was lost by the men through caisson disease, the cases being only slight. Under this pressure 330 men were employed for 36 days, working 3 hours on, 3 hours off and 3 hours on. It is true that no green men were used on this work, as there were plenty of experienced air men available at that time.

The third diagram on Fig. 4 shows the desaturation curve and rate of decompression, leaving the saturation of the blood equivalent to 27 lbs. on reaching atmospheric pressure. This result bears out in part the periods of decompression of Table IV, and, if a more rapid passage had been made through the first and second locks, probably a better result would have been attained, as the equivalent pressure of the blood would have reached 25 lbs. on coming out, as shown by Fig. 5 instead of 27 lbs.

In caissons or tunnels with but one lock, it is a difficult problem to allow workmen as long a time as Table IV indicates, as no one can enter the air-lock during decompression. One method of overcoming this difficulty would be to provide a lock with two small end chambers and a larger center chamber, four doors in all being necessary. Anyone making a short visit to the caisson could pass through without disturbing the pressure in the middle decompressing chamber. Fig. 6 is a diagram of such a lock with connections.

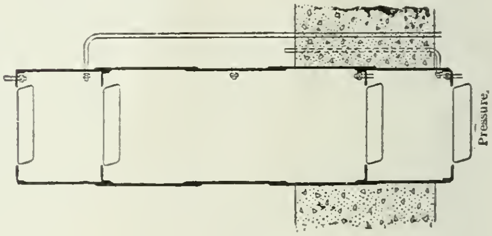

FIG. 6.

Some one has suggested, for diving bells and caissons, a detachable chamber like a boiler which the men could enter, and thus take as long as necessary to decompress.

The men on the East River tunnels rebelled against 15 mins. for decompression, but, after putting the responsibility up to the foremen, in time they found that it was a safeguard and voluntarily lengthened the time to 20 mins. and gladly submitted to 48 mins. for 40 lbs.

The death rate due to caisson disease was comparatively small, averaging 19-100 of 1 per cent. for the whole of the compressed-air work, and, from the experience gained, it would in all probability have been much higher if the decompression had not been lengthened.

The fact that the only recognized cure for caisson disease is recompression in a medical air-lock followed by slow decompression, is a powerful argument in favor of slow decompression, and where it is at all possible, in future works, regulated decompression will in all probability be adopted.

In caissons with small air-locks the volume of air remaining when the lock is full of men is very slight, and very rapid decompression takes place. The workmen have a good opportunity to become seasoned in a caisson, as the pressure begins at 1 or 2 lbs. and gradually increases day by day as the caisson sinks, and the highest pressures are required for but a few days.

On the East River tunnels two caissons were sunk to a final pressure of 33½ lbs. and very few cases of caisson disease occurred, none of which were fatal although the decompression was rapid. On the other hand, on account of the tunnels on the Manhattan side starting out at a high pressure, the men had no chance to get seasoned, and many cases occurred, though the time of decompression was regulated, but not to such an extent as Table IV indicates.

Thus far, practically, no grandfatherly legislation hampers engineers in the United States in compressed-air work, but such legislation is threatened, and engineers should be prepared to guide it. The engineer is confronted with conflicting testimony on all sides, and, though his experience shows that some men are capable of rapid decompression without injury, he also knows that many men are injured. Because a few men can for a time rashly take the risk, shall he eliminate good men from compressed-air work by putting them to such a test without endeavoring to make it safe for all who are physically sound?

AN AMERICAN EXPOSITION AT BERLIN, 1910

An American Exposition is to be held in the Exposition Palace near the Zoological Garden in Berlin through the months of April, May and June, 1910. The exposition is intended to educate the European, and especially the German, population, to the importance and excellence of American manufactured products. The exhibits will be limited to articles of proven merit.

Everything will be provided for the exhibitor, so that when the exhibition price for space occupied is paid this will include all the items which usually figure as extras. Further particulars are obtainable from Max Vieweger, Manager, Hudson Terminal Buildings, 50 Church Street, New York

UNIQUE COAL MINING RECORD.

Eighteen years of coal mining, without a fatal accident from exploding gas or dust, is an excellent record for any mine. It is especially deserving of praise because the company achieving it is the largest coal producer in the world. Readers will find much that is unusual in the methods of preventing danger and accident, employed by the coal mining department of the United States Steel Corporation, as described in an article on the Gary, West Virginia Mines. Separate underground roads for the use of men only; prohibition of solid shooting; insistence on proper care of workings; scientific ventilation, and bonuses to officials for clean accident sheets, are a few of the causes which impelled the state mine inspector to report to Governor Dawson that these were the best mines he ever entered in his life. Such rules and conditions constitute a form of liability insurance which would be a profitable investment for any industrial corporation. Aside from the protection to human life, the effect of such an attitude upon the minds of employes is an incitement to better work and a deterrent to labor troubles.—*Mine and Quarry.*

CHILDREN AND ELECTRIC WIRES

Mr. William Carroll, city electrician of Chicago, has sent a letter to the president of the Board of Education of that city directing attention to this important subject. Mr. Carroll thinks, and with good reason, that instruction on this subject should be given to the children of the public schools. There have been so many accidents caused to boys who come in contact with live electric wires by climbing poles on a "dare;" by picking up the loose ends of telephone wires that have come in contact with electric wires carrying dangerous potentials; by taking hold of broken electric-light wires; by throwing pieces of wire over trolley or other overhead wires to "see the sparks fly;" by using a piece of wire as a string with which to fly kites and having the wire come in contact with live electric wires, or by similar causes—that the danger is shown by experience to be a very real one, which must be guarded against. Mr. Carroll contends that the children should be taught to avoid wires of all kinds as they would rattlesnakes.

FANS CIRCULATE BACTERIA

In Brussels an investigation has been made of the effect of ventilating fans in restaurants and other public places. Some of the ventilators simply agitated the air, while others were connected with openings in the wall. The experiments were made by determining the number of bacteria in a cubic meter of air before the ventilator had been started and after it had been running an hour or two hours. The results may be summarized as follows: In a number of cafés and restaurants the number of bacteria in a cubic meter of air, in the morning before the ventilators were started, ranged from 10,000 to 22,000. After an hour's running the number ranged from 17,000 to 48,000; after two hours' running the number ranged from 27,500 to 85,000. Another experiment was made in a laboratory where remedies for tuberculosis were prepared. Here the number of bacteria rose from 8,500 before the ventilator was started to 45,000 after one hour's running and to 75,000 after two hours' running. Another experiment was made in a private parlor. The number of bacteria per cubic meter, 650 before the starting of the ventilator, rose to 2,500 in one hour and to 4,000 in two hours. The ventilator was then stopped. Two hours later the number of bacteria per cubic meter had fallen to 700. These figures are so eloquent, that no further discussion is needed to show that the ventilators used in all these cases did far more harm than good, by creating a lively current of air which stirred up and carried with it dust containing bacteria.—*Scientific American.*

DRILLS ADOPTED ACCORDING TO CONDITIONS

The selection of methods and tools for given purposes, in order to achieve the highest degree of operating economy, demands incessant study and an ability to accept the results of others' experience. In certain mining districts two-man rock drills of one or another size have come to be regarded as "standard," for all work. Miners in these districts have been surprised to find how much more economical a light, or "one-man" drill is for many purposes, and the innovation, which has been "standard" in other fields for years, is rapidly making converts. In like manner, drills larger than "standard" have been introduced in camps where hard times had closed many operations, with the result that mines have thereby reduced their costs of ground breaking and are running on ore too lean to show a profit under the usual system. Here is a practical subject for mining institutes and congresses to study.—*Mine and Quarry.*

WHERE TO FIND THE MONEY

As to whom to approach in the search for financial backing, there can be no very definite advice. Usually there are a number of young men in every community whose parents are well to do, and who will advance a moderate amount of money to establish their sons in business. The names of such people can often be obtained from local bankers.

Business men, as a rule, have use for all the capital they can command, and are not likely to put money into stock companies that they do not control. On the other hand, professional men, like doctors, dentists, lawyers and architects, are much more apt to listen with favor to a proposition to invest in a stock company. Men of all classes who have come into money quickly, whether by inheritance, by speculation, or by a fortunate stroke of busniess, are nearly always ready to give ear to a business project that offers a greater return on their money than can be had from mortgages or bonds.

Engineers who try to secure financial backing for any project usually make the mistake of not studying the types of men to whom they wish to present it. They put in weeks, months, or possibly years, studying the engineering and commercial aspects of the problem. Then they go to some banker, to some professional promoter, or to some successful business man, and meet discouragement. The banker wants security, the promoter wants a "retainer" to start with. The successful business man wants more money for his own business. All want exactly what the engineer himself is in search of. Avoid people of these classes in financing a small business in which you seek to retain control; but go among salaried men, among professional men, among wealthy parents who have sons, and among people who have come suddenly into the possession of money. Among such people, a sound business proposition, if not on too large a scale, will always find the desired financial backing.—*Engineering-Contracting.*

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AEROPLANE PROGRESS

It is absurd for any monthly publication to attempt the function of the *news*paper. News is made so rapidly, new things follow each other so closely, that even the dailies have to multiply their editions to keep up, and there is then a constant strife between the rivals for priority. It is as the historian rather than as the news purveyor that we mention the latest achievements in aviation at the moment of writing.

Louis Bleriot crossed the English channel with a small monoplane flyer on July 25, winning $5,000 offered by the London *Daily Mail.* The distance of 21 miles from the cliffs near Calais to Dover was covered in about 25 minutes, or at 50 miles per hour, with an average elevation of 250 feet.

Hubert Latham with a much larger machine made two attempts, once before and once after the above, descending the second time into the sea about two miles from Dover.

Orville Wright, on July 27, completed the official endurance test of the flyer which the Wright Brothers are under contract to furnish the U. S. Army Signal Corps. The test was for sustained flight with a passenger, and the drill grounds at Fort Myer, Va., were circled 77 times in 72 minutes at an average height of 50 feet, although as high as 125 feet was reached. On July 30 the contract requirements were all completed by a ten-mile cross-country flight with a passenger, and the Wright brothers will receive $30,000 for their machine.

No true historian can note the sequence of events without attempting to discover their connections and interdependencies, the invisible links in the so far completed chain of causes and effects, and no better opportunity could offer for the exercise of his function than in the mechanical successes of the age. When a thing is accomplished the achievement is apt to appear so simple that we all wonder why it was not done before, but later we find that one thing has been waiting for another all the way along, and that none have been able to go fast or far alone This is most evident in the present status of the aviator. What it has waited for all along, what has prescribed its rate of development and achievement, what still holds it down is the motor. That in the course of events, and by the cooperation of the many, it will be made more reliable and more capable of sustained and uninterrupted action none can doubt, and then we may not say how far and how safely mechanical flight may be carried. The up to date successes of the flying machine show us how those have helped it along who perhaps never thought of what would result.

ROCK DRILL HISTORY—GENERAL HAUPT

A recent issue of *Mining and Scientific Press*, San Francisco, said that the first successful rock drill was designed by Sommeiller for the Mont Cenis tunnel and actually used in 1861. This elicited from a correspondent an interesting narrative enforcing the claim of Gen. Herman H. Haupt as the real pioneer in this field.

While yet a lad, he writes, I was fortunate in being thrown into close contact with General Haupt for a brief space, and the memory of the charm of his home life, the kindliness of his nature, and the rectitude of his spirit, remain with me vividly to this day. It was during this time that I first heard of his work at the Hoosac tunnel, and how the remarkable speed while the tunneling was under his direction had been accomplished by his invention and perfection of the rock-drill; and I recall being told that, after Governor Andrew had wrongfully succeeded in wresting the work from him, he was given a banquet by an engineering society in England as a recognition of his work in tunneling and in the invention of the rock-drill.

This is a boy's recollection of twenty years ago. Let us see if it can be verified. In "Reminiscences of General Herman Haupt," written by himself, appears on page 28, among "notes and a personal sketch by Frank A. Flower," the following: "At the time of the suspension of tunnel work in 1861, Mr. Haupt had made great progress in rock-drilling machinery, and had developed a machine that was far in advance of the perforator at work in the Mont Cenis tunnel at the same time. This drill was improved by a Mr. Taylor, in the employ of J. A. McKean, who represented Mr. Haupt in Europe and accomplished more rapid progress, at less expense for repair, than any drill used in the St. Gothard tunnel or elsewhere in the Old World; but Haupt never received any royalties or other compensation for its use. Mr Haupt's knowledge of engineering principles, his great energy and experience, his genius for inventing more efficient rock-drilling and other machinery, and his tact and economy in the management of men . . . would have resulted in completing the tunnel without a cent of cost to the State;" and on the same page is the following: "For some years subsequent to the war, General Haupt followed his profession of consulting engineer in Pennsylvania. In 1867 he visited Europe, upon invitation of the Royal Polytechnic Society of Cornwall, to explain his system of mining and tunneling by power machinery. One of the rock-drills invented by him for use in the Hoosac tunnel, and which was the type of those used in driving through the great St. Gothard tunnel with so much rapidity, was on exhibition and received the highest honors awarded by the society."

The Hoosac tunnel was begun by Mr. Haupt in 1856, and his work there was continuous until 1862. My recollection is that Mr. Haupt perfected his drill one year after beginning work, which would make it in 1857, and give it priority of practical usage, and I believe the claim can be established that he also had priority of conception, although he never, to my knowledge, patented his device. It seems quite certain that, although the Mont Cenis tunnel was completed in 1870, and the St. Gothard not begun until 1872, it was the Haupt form of drill that was the most effective in the latter tunnel, and neither the Sommeiller nor the Mont Cenis form.

WATER TRANSPORTATION IN EUROPE

"When I was in Berlin a few weeks ago, I met an American who was establishnig European agencies for the sale of a certain variety of glue, manufactured at Gloucester, Mass. In the course of our conversation he remarked that he could lay down his freight from Gloucester to Berlin for less than it costs to send it from Gloucester to Chicago.

"Now Berlin is rather more than 100 miles from the sea, but freight laid down on the docks at Hamburg is taken to the capital, through a veritable network of canals and canalized rivers, at a cost less than half what railroad transportation would involve. The

Elbe, the Rhine and the canals connecting and tributary to them are busy lanes of commerce, in sorry contradistinction to the deserted state of our canals and rivers. The ordinary type of boat is a barge of 200 to 250 tons burden sometimes propelled by a small engine, more often towed in strings by a tug.

"You will not see in France, Belgium or Germany deserted canals, waterways ruined by railroad encroachments, or such a pathetic spectacle as exists on several routes in the United States, railways running along the bank of a dry canal, all the locks on which have been blown up, lest it should be applied again to its proper function. No one of the three European states I have referred to could do its business without canals, and the business men of Berlin frankly admit that without artificial waterways the city would be a political capital and nothing more.

"To-day a cargo of cotton from Charleston, New Orleans, or Mobile goes straight to the docks at Manchester. But except in a limited area, and one continually decreased by railroad intrigue, our producers must use land carriage to get their cotton to the sea. If Manchester can profitably do so much for its manufacturers, cannot the United States do even more for the cotton planters of the South, or the wheat growers of the North?"—*Nashville Banner.*

THE ELECTRIC AIR DRILL INDEPENDENT OF ALTITUDE

Two Electric Air drills have been put into successful operation at the Germania mine of Lizandro A. Proano, in the Huarochiri district of Peru. The elevation of the mine is nearly 16,000 feet, the absolute pressure of the atmosphere being only 8 pounds.

The rock at this mine is considered the hardest in Peru, and while progress with hand work was very slow it was considered hopeless to try to install machinery, the bad roads and the distance from a railroad forming additional discouragements. The drills were, however, determined on, at least as an experiment, the complete installation comprising a 45 kw. General Electric generator driven by a direct connected Pelton water wheel, and two Electric Air drills of the largest size, these each having a 5 h. p. motor.

The plant was put into operation as soon as possible after its arrival, Mr. Dick, of the commercial house of W. R. Grace & Co., taking charge of the work and also that of instructing the operators. They learned the complete management of the machines so rapidly that in a short time the drilling of the principal tunnel was under way, working with but one of the drills and advancing at the rate of a meter per day. As the progress which had been made by active hand work was only at the rate of 3 meters per month the advantage gained by the use of the drills was sufficiently evident.

This employment of the Electric Air drill emphasizes the fact that in its working it is entirely independent of altitude, or of the external air pressure, high or low. The air used is in a closed circuit, the high pressure which drives the drill piston in either direction and the very low pressure for the alternate movement being produced by the action of the pulsator pistons upon constant and unchanging—as to quantity—masses of air enclosed in the cylinder ends and in the connecting hose. The only compression of free air is that which is done automatically by the machine to compensate for the slight leakage losses. To operate regular air rock drills at this altitude the compressor would require to be nearly double the capacity of one at sea level for the same work.

A WINDMILL SUGGESTION

Why is the full circle of a windmill of the modern type filled with blades? The only space not filled is the central eye and such small space as is represented by the angularity of the blades. The consequence of this may be that the wind deflected from the moving blade will be directed against the next following blade, and will hinder the rotation of the mill. With fewer blades the wind would pass away more freely, and it is likely that there would be more power generated per blade, if, indeed, not actually more power from a mill of a given diameter. The efficiency of the surface would probably be better. An ordinary windmill is simply an impulse turbine without guide blades. The wind advances in a parallel flowing stream and strikes upon the sloping surface of the sails or blades. These slip away under the lateral pressure of the air, and the air is deflected in the opposite direction, and can only get away between the blades. Such, at least, appears to be the trend of some recent thought on the question, and there is some reason in it. The old Dutch mills had only four, five or six sails, as a rule. By no means was the full circle covered with sail area. Indeed, a mere fraction was occupied, and much greater sail area could probably have been added. The modern windmill is quite different, and has its whole circle occupied. Are there any tests on record to show what is the effect of this, and is it not quite likely that investigation would lead to changes in design?—*Cassiers.*

DETAILS OF MINING PRACTICE

The aim of the miner is to take out ore at the lowest possible cost. In mining, the work of developing new territory and of exploiting the ore bodies already discovered is carried along at the same time. The work of prospecting is the main one at the beginning and at the end of the mine's life. It is necessary in the early days for the discovery of the ore bodies, and a property is not closed down until the work of exploration, which is done long in advance in a well-conducted mine, fails to expose new ore bodies.

The ore bodies are reached by a main thoroughfare, which is a shaft or a tunnel. Numerous side roads branch from it, and in their turn subdivide themselves often into smaller paths leading to rooms of various sizes.

In a flat country the thoroughfare is a shaft which may be straight or inclined but which goes down, and has for main utility to reach greater and greater depths. The side roads branching from it are the drifts or the tunnels run at regular depths, each usually one hundred feet deeper than the one above. As these side roads explore the vein on a given level they are called levels. These are the roads which lead to the rooms having no outgoing doors, such as the stopes. The stopes are the excavations in the ore.

The winzes, or small auxiliary shafts sunk from some level underground, and the raises, or chimneys raised from one level to another, are the short cuts between two levels.

The ore bodies lie in areas, which are cut as much as possible into blocks and squares and which are surrounded by the various roads and reached by them.

In good mining practice the ore bodies of one level are taken out, while in the one or two levels below these the blocks of ore are divided and the roads built for every day use. Again, in the two lowest levels new productive areas are discovered, the shape and the extent of the ore bodies are ascertained and the pathways that will permit the taking out of the ore in the cheapest and best way are planned and started. At the same time some roads may be driven into the country rock and fail to encounter the ore bodies which were hoped for along their course.

Each morning the men with their tools, powder and a supply of candles go down the shaft. A part of the men leave at each level—the first, the second, and so on—until the last one is reached. At each level the crew divides again, a part branching off to the left and the other to the right; and, again, along the drift the men separate to go to their different places in the stopes, till the mine is alive with men at work.

From all the extremities the ore comes down ore chutes to bins or storerooms above the drifts. From there it is dumped into small steel cars and the ore or waste rock, as the case may be, is trammed to the shaft and hoisted to the surface.

On the surface, if the car is full of waste rock coming from some barren portion of the vein or from some road driven through the country rock, it is piled on the waste dump. The car takes another switch if it is filled with ore and is dumped into large storerooms, called ore bins. The ore lies there till it is taken later on to some mill or smelter, where the metals are extracted:

When the mine is opened on the slope of a steep mountain it is much easier to use a main working tunnel instead of a shaft and branch roads, as crosscuts to the veins, drifts on the vein at the various levels, winzes and raises, are all connected with the lowest and main tunnel through which all ore taken out is finally trammed.

It seldom happens that the vein lies flat in the ground. In mines on veins dipping but slightly the main thoroughfare is a long tunnel, slightly inclined like the vein, which it follows, and called a slope. Each hundred feet roads are pushed to left and to right from the slope.

Some veins present near the surface a wide split up and the ore body can be taken out by a quarry or gigantic open cut.

The mine workings are cut in the solid rock by hard and patient work and at a great expense. In following the miner from the time he enters the mine it is easy to learn how he opens the roads through the solid rock with the use of dynamite, and to recognize what are the different roads, shafts, tunnels, raises or winzes. When the ore has been reached it has to be removed. During the last fifty years great strides have been made in the art of mining which allow one to get the best results in nearly all the emergencies which may arise.—*Etienne Ritter in Mining Science.*

A CANAL TO CONNECT THE BALTIC WITH THE BLACK SEA

A mixed syndicate of Russian and French financiers has approached the Russian government to obtain a concession for the construction of this great canal. The total cost of the work, plans for which were elaborated many years ago, has been estimated at $250,000,000.

The canal will begin at Riga and finish at Cherson, about 1600 miles, which could be traversed in 12 days as compared with 45 days for the Gibralter route. The minimum breadth of the canal is to be 140 feet and the depth 14 feet. From Riga to Beschenkowitch the course of the river Driva will be followed and the necessary work will consist of dredging and widening where required. From Beschenkowitch to Kopis-on-the-Dueiper, about 60 miles, will have to be cut out, and from Kopis to Cherson the Dusiper will be followed to its outlet on the Black Sea. This last stretch of 1200 miles will not present many difficulties for the engineers, but the overland portion will be very trying. Beschenkowitch is 378 feet above sea level and the ground rises steadily until the southern river is met. This will necessitate a great number of locks, and a subsidiary canal will have to be cut from Pripotz on the Gorin Sea to provide the requisite water. Quick construction is contemplated, so that if the work is begun within the present year it can be completed in 1914.

SULPHUR DIOXIDE IN THE AIR

Writers in the past have paid but little attention to the presence of sulphur dioxide in the air. Various diseases of the air passages may be very materially influenced by the presence of this gas, and its effect on the general health of people is undeniable. It has been calculated that for every ton of coal burned in London something like three tons of carbon dioxide are produced, or about 90,000 tons per day. At the same time about 2,700 tons of sulphur dioxide are poured into the air. The effect of all this poisonous gas polluting the atmosphere cannot but be prejudicial to the general health of the community. To prevent such fouling of the air in all cities where there is a great consumption of coal, legislation should be enacted, making it a misdemeanor to throw out waste sulphurous gas into the air and a means should be devised to save the gas which is produced when coal is burned. Many useful applications of sulphur dioxide could be made which would more than cover the cost of its removal from the escaping furnace gases. —*Dr. Theodore W. Schaffer in the "Boston Medical and Surgical Journal."*

ABANDONS "SIMPLIFIED" SPELLING

For two or three years "simplified" spelling has ruled more or less in the pages of *Profitable Advertising.* That journal and the *Selling Magazine* having now become one, under the title of *Advertising and Selling,* the following announcement is made:

The editor and publisher of P. A. had decided to return to Webster, and the simplified forms of the few words thus spelled would have been abandoned in the June number had there been no change in name or management.

The only argument against the recommendations of the Simplified Spelling board is the fact that the people do not like them. During the three years that P. A. spelled a few words in the simple manner, its course in that respect *was not once commended by one reader, and was constantly condemned by many readers.*

Inasmuch as it is an indisputable fact that our language has come to its present spelling estate through no other agency than the good pleasure of those who have spoken and written it, there seems to be no good reason for now attempting to deny to them that privilege. It seems also to be a fact that the simplifyers are trying to add to the broth an ingredient which they decline to allow to be incorporated. They carefully consider the scientific requirements of the formula, and prescribe the proper compound, only to discover that they are not able to induce a union—nothing better than a mixture—and that as soon as they quit stirring the mixture the few ingredients are precipitated, and the broth clears itself of them. So we rather regretfully abandon the simpler and more scientific and sensible forms of several words and return to Webster and the enphatically expressed predilections of our readers. The Simplified Spelling board endeavors to travel too fast in a direction in which the people do not wish to move at all.

LIGHTNING FIRES A BLAST

A half acre of solid stone, twenty-two feet in thickness, was lifted by a single shot, and that shot was fired by a bolt of lightning at the Standard Lime and Stone Company quarries at Fond du Lac recently. Superintendent H. J. Murphy had just completed plans for a big shot. Eighteen deep holes had been drilled, in which 2200 pounds of dynamite had been placed and electric appliances attached. Noting an approaching storm, the superintendent gave the word to hurry, and before connecting up the battery to fire the shot took the precaution to run down the lead wires to avoid a chance of short circuits. Running one wire through either hand he started for the ledge where the charge was placed, when within ten feet there came a blinding flash followed by a terrific explosion, in which all the charges were fired and the half acre of stone hurled high in the air. Mr. Murphy's hands were severely burned by contact with the wire, but neither he nor his assistant was injured by the falling stone.

NOTES

Heating a building with hot water from the jackets of a gas engine is to be tried at Detroit, in conjunction with a 1400-hp. engine and producer plant now being built for the Ford Motor Company.

The deepest producing oil well in the world is believed to be a well of the Los Alamos Oil Co. near Los Alamos, Cal., in the extension of the Santa Maria Field. It is 4,350 ft to the bottom and has yielded 600 barrels a day of 35 degrees gravity oil. The drilling of this well required two years.

The report of City Engineer Poetsch of Milwaukee gives the cost of a tunnel 7 ft. by 6½ ft. high, built last year under the Kinnickinnic river as $47 per linear foot. The tunnel, which was built to carry a water main under the river, is 295.3 ft. long, concrete lined, runs about 60 ft. below the surface of the river, the material penetrated being solid limestone. The cost of the shafts was $73 per linear foot.

The critical temperature of a substance is defined as being the temperature at which that substance will remain a gas, no matter what the pressure may be. According to Boyle's law, the volume of a gas is inversly as the pressure which it bears. Therefore, after passing the critical temperature a gas may be compressed to a greater density than if it were a solid.

The Sullivan Machinery Company has installed a branch office at Australasia Chambers, Martin Place, Sydney, New South Wales, to further the sale of its air compressors, rock and diamond drills, coal cutters, etc., in the Australasian commonwealths. Its establishment is due to the growing importance of the mining industry in that field. The new office is in charge of Mr. Geo. R. Mair.

A phenomenal jump in the world's tunneling record is reported. It will be remembered that in the Simplon tunnel 685 feet was driven in one heading in July, 1904. The north heading of the Loetschberg tunnel was advanced 990 feet in the month of June of this year. This heading is being driven in limestone, while the south heading is in crystalline schists crossed by dykes of porphyry, and here an advance of 545 feet was made for the same month.

A world's record for hand work tunnel driving comes from California, where in the Fernando tunnel of the Los Angeles aqueduct an advance of 579 feet for the entire tunnel section was made in the month of May. The ground is a soft sandstone with many nodulous boulders and frequent strata of hard altered sandstone. The volume of excavation is about 5 cu. yds. per lineal foot. From 14 to 17 holes are required per round. The men work in three shifts of 16 men each.

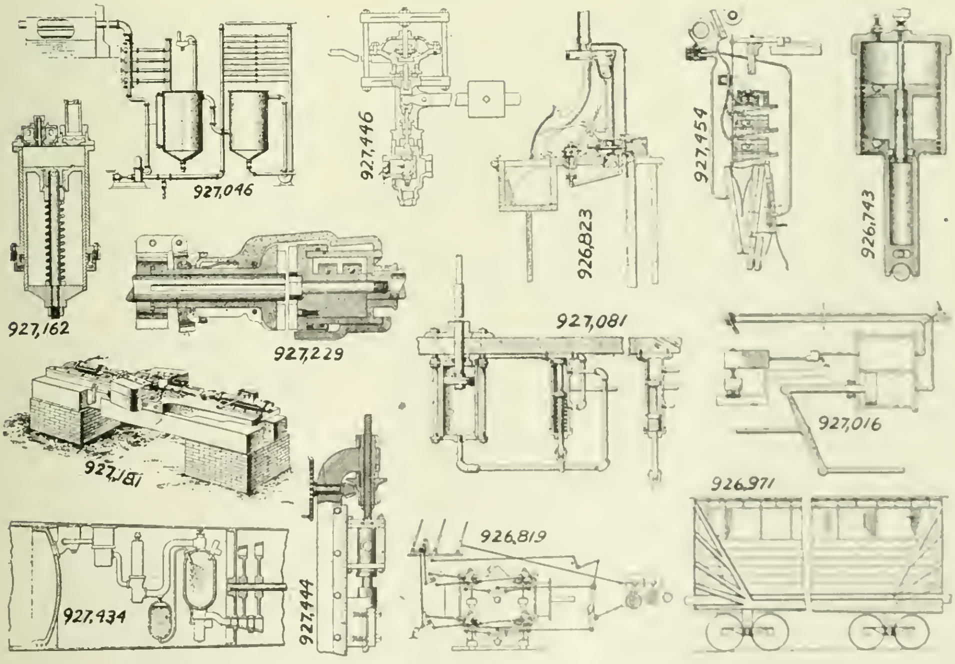
The Smithsonian Institute will erect on the very summit of Mount Whitney, Cal., (altitude 14,500 feet) an observatory which will enable investigators to study atmospheric conditions at great elevations, in dry air, and in clear skies. The observatory will be erected from the Hodgkins fund, and will comprise a three-room structure of stone substantial enough to stand for centuries.

Mixtures of air and aluminum powder are very liable to explosion. Recently, in a factory near Nuremberg, where a metallic surface is given to paper by the use of aluminum powder, the breaking of the globe of an inclosed arc lamp caused an explosion which killed two men and wounded several others.

The headings of the Gunnison Tunnel on the Umcompahgre Valley Irrigation Project of the U. S. Reclamation Service met on July 6. Work on this tunnel was started some four years ago. The tunnel was driven from two points some six miles apart, one on the Gunnison River, where the water supply comes, and the other at Montrose in the Umcompahgre Valley. The tunnel is to have a concrete lining, the finished section being 10½x11½ ft.

We "consume" much more than we actually eat or drink. For every man, woman and child of the ninety millions in the United States there is produced each week: Three-quarters of a pound of wire, more than three-quarters of a pound of rails, half a pound of structural shapes, three-quarters of a pound of plates, one-third of a pound of sheets, three-quarters of a square foot of tinplate, two and a half pounds of bars, hoops, etc., four pounds of iron castings. These and other finished iron and steel products make a total of twelve or thirteen pounds each week per head.

The Zeitschrift für Eis-und Kälte-Industrie says that the marine engineer, Dibois, breaks up river and sea ice by means of high temperatures. He divides the field into grooved squares, and deepens the grooves by means of a hydro-oxygen blast, produced on a sledge weighing 359 pounds, which lies outside, not over, the groove, so that the attendants do not risk a wetting if the ice should break unexpectedly. The sledge must be closely followed by workmen to remove the blocks of ice before the water in the grooves can freeze again, which can be delayed by the addition of a little salt.



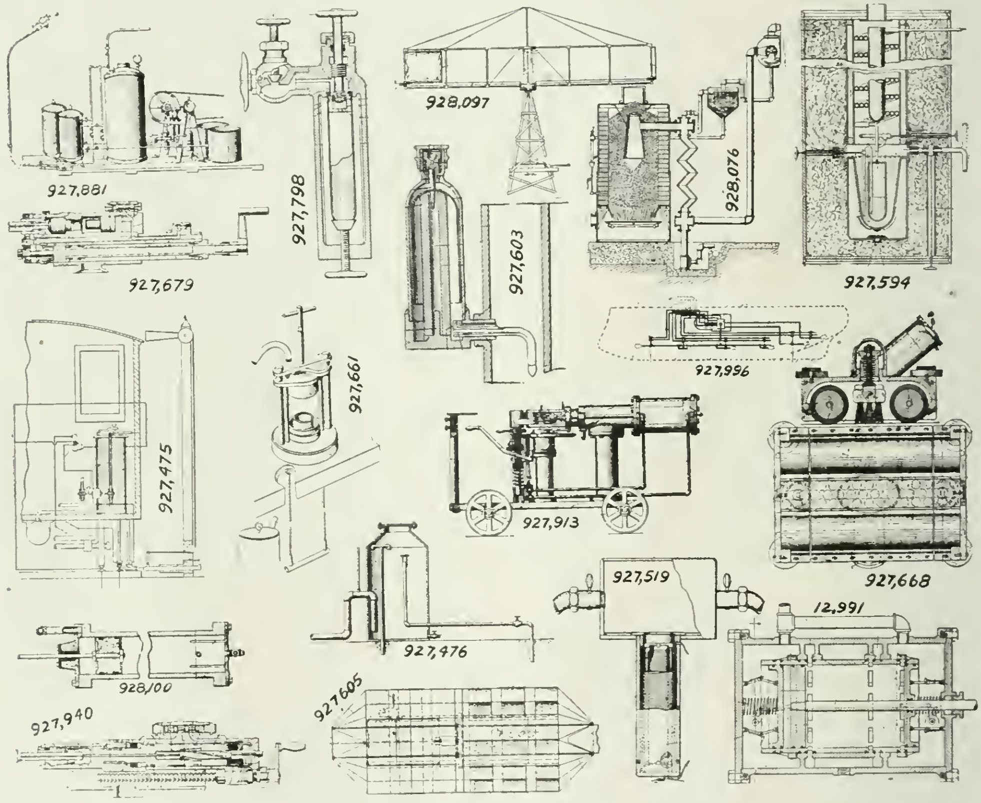
PNEUMATIC PATENTS JULY 6.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

JULY 6.

926,743. RAILWAY-SIGNAL. John S. Hobson, Edgewood Park, Pa.
926,819. COMPRESSED-AIR ENGINE. Bruno V. Nordberg, Milwaukee, Wis.
926,823. PNEUMATIC-DESPATCH-TUBE APPARATUS. Albert W. Pearsall, Lowell, Mass.
926,824. CARRIER FOR PNEUMATIC-DESPATCH-TUBE APPARATUS. Albert W. Pearsall, Lowell, Mass.
926,971. MEANS FOR REDUCING AIR RESISTANCE ON VEHICLES. George A. Ahrens, Mukwonago, Wis.



Pneumatic Patents July 13.

926,972. METHOD OF AND APPARATUS FOR DRYING AIR. David Baker, Philadelphia, Pa.
927,016. AIR-BRAKE. Andrew J. Wisner, Philadelphia, Pa.
927,046. METHOD OF TREATING ORES. Hascal A. Hogel, New York, N. Y.
927,081. GARMENT-PRESSING MACHINE. Edward Schumann and Albert Prepejchal, Chicago, Ill.
927,162. AIR-COMPRESSOR. Thomas O. Perry, Chicago, Ill.
927,181. ROCK-DRILL MAKING AND SHARPENING MACHINE. Grant W. Smith, Ottumwa, Iowa.
927,229. PNEUMATIC CLUTCH. James C. Garrett, San Francisco, Cal.
927,434. AIR-HEATER FOR COMPRESSED-AIR ENGINES. Harold W. Shonnard, East Orange, N. J., and William Dieter, New York, N. Y.
927,444. STONE OR ROCK CHANNELING MACHINE. Albert Ball, Claremont, N. H.
927,446. VACUUM-GOVERNOR. George H. Beebee, Marshalltown, Iowa.
927,454. PNEUMATIC ACTION FOR MUSICAL INSTRUMENTS. Lewis B. Doman, Elbridge, N. Y.

JULY 13.

927,475. SAFETY APPARATUS FOR MOTOR-CARS. John Barberie and Thomas J. Walsh, Brooklyn, N. Y.

1. In a motor car provided with a motor, a feed conductor, a return conductor, an air reservoir and air brakes; devices arranged in an incomplete electrical circuit and in operative connection with said reservoir, air brakes and motor and external means connected with a signal for completing said circuit.

927,476. NATURAL-GAS SEPARATOR. Arthur W. Barker, Fort Pierre, S. D.
927,519. OZONE - GENERATOR. Theodore Friedlander, Chicago, Ill.
927,594. AIR-LIQUEFIER. James F. Place, Glenridge, N. J.
927,595. APPARATUS FOR COOLING AND PRESERVING FOODS, ETC., BY LIQUID AIR. James F. Place, Glenridge, N. J.
927,603. AIR-VALVE. Frederick H. Sauer, New York, N. Y.

927,605. AEROPLANE. JOHN SEILER, Union Hill, N. J.

927,661. PRESSURE CASTING APPARATUS. ROBERT N. LE CRON, St. Louis, Mo.

1. In a pressure casting apparatus, the combination with the receiver for the flask formed in separable sections movable one toward and from the other and the lower sections being provided with a bottom vent, of a flask having a perforated bottom and a peripheral flange around the perforated bottom adapted to seat in the lower section around the said vent, whereby air and gases may be forced from the receiver through the flask.

927,668. PNEUMATIC SWEEPER. ALBERT E. MOORHEAD, San Francisco, Cal.

12,991. VALVE MECHANISM FOR ENGINES AND COMPRESSORS. SIDNEY A. REEVE, New Haven, Conn. (Reissue).

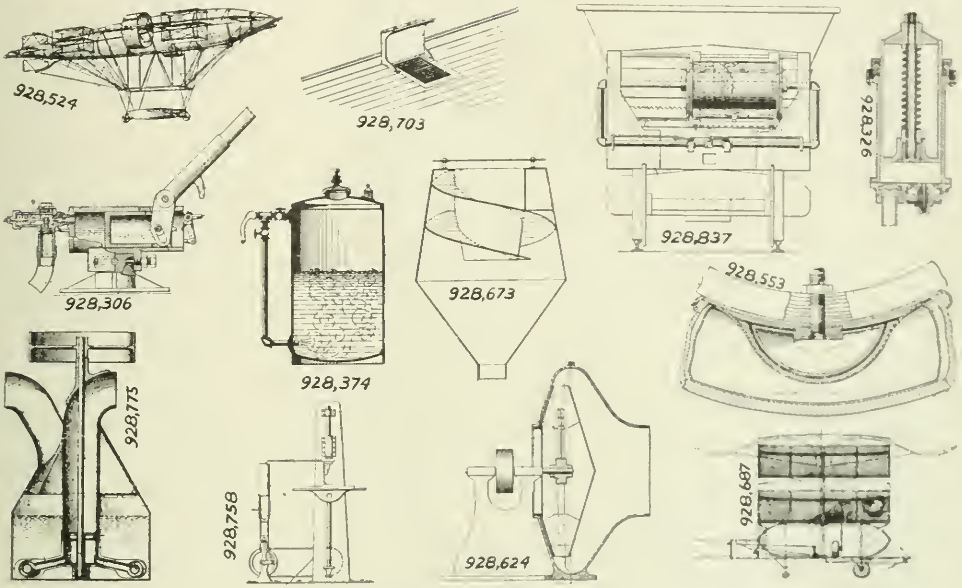
JULY 20

928,296. PNEUMATIC ACTION FOR MUSICAL INSTRUMENTS. PETER WELIN, Newcastle, Ind.

928,306. TROLLEY - POLE - CONTROLLING MEANS. CHARLEY E. COZZENS, Toledo, Ohio.

928,324. APPARATUS FOR GENERATING HOT COMPRESSED GAS. HANS NEUMANN, Berg Gladbach, Germany.

928,326. AIR-COMPRESSOR. THOMAS O. PERRY, Chicago, Ill.



PNEUMATIC PATENTS JULY 20.

927,679. DRILLING-MACHINE. CHARLES B. RICHARDS, Cleveland, Ohio.

927,798. TRANSFERRING APPARATUS FOR FLUIDS UNDER HIGH PRESSURES. JOHN A. HOFF, Cincinnati, Ohio.

927,881. METHOD OF AND APPARATUS FOR ATOMIZING, ETC. ANTENOR SALA, Mexico, Mexico.

927,913. BOTTLE-BLOWING MACHINE. SAMUEL E. WINDER, Salem, N. J.

927,940. ROCK-DRILL. SANFORD W. BROTHERS, Denver, Colo.

927,996. SYSTEM FOR PROPELLING VESSELS. THOMAS MOTTON, Toronto, Ontario, Canada.

1. In a system for propelling vessels, a plurality of outlet ports through the hull below the water line, an air compressor suitably situated in said hull, conveying tubes or conduits communicating between said air compressor and said outlet ports, gate valves arranged in said conveying tubes or conduits adjacent to said outlet ports, a valve cylinder arranged in combination with said gate valve, means for operating said valve cylinder and gate valve, as and for the purposes specified.

928,076. APPARATUS FOR CONVERTING VOLATILE HYDROCARBONS INTO FIXED GAS. HARRY F. SMITH, Lexington, Ohio.

928,097. WINDMILL. JOSEPH BARKER, Carson City, Nev.

928,100. HOISTING-CYLINDER. MILFORD F. BERRY, North Bangor, N. Y.

928,181. VALVELESS PNEUMATIC TOOL. JOHN F. CLEMENT, Philadelphia, Pa.

928,334. PNEUMATIC TIRE. ROBERT J RUTHS, Baltimore, Md.

928,357. PNEUMATIC MUSICAL INSTRUMENT. THEODORE P. BROWN, Worcester, Mass.

928,374. PAINTING-MACHINE. HIRAM E. FORD and FRANK E. TAYLOR, Detroit, Mich.

1. A pneumatic paint machine comprising a combined paint reservoir and pressure tank, an atomizer connected with the tank above the level of its contents to receive air under pressure therefrom, a paint suction pipe leading to said atomizer from the tank below the level of its contents, and means for introducing air under pressure to the tank below the level of the tank contents.

928,411. VALVE FOR PNEUMATIC TIRES GRACE DE VIGNE, Cheltenham, England

928,433. PNEUMATIC-TIRE ARMOR CHARLES E. EVANS, Council Bluffs, Iowa

928,524. AIR-SHIP. SIMON LAKE, Bridgeport Conn

928,553. SIGNAL FOR PNEUMATIC TIRES. SAMUEL SILVERMAN and JOSEPH E. TRAHAN, Watertown, N. Y

928,624. PRESSURE-BLOWER. EDWIN BASSLER Chicago, Ill.

928,673. CENTRIFUGAL APPARATUS FOR SEPARATING SOLID MATTERS FROM AIR. ANDRE LEBRASSEUR, Paris, France.

928,687 AEROPLANE AIR SHIP FRANK A NEWELL, Terry, Mont

928,703 HOT-AIR MOISTENER AND DEFLECTOR WILLIAM M. ROFOER, Bloomington, Ill

928,729 LIQUID GAS SUITABLE FOR ILLUM-

INATING AND HEATING PURPOSES AND METHOD OF MAKING SAID GAS. Linus Wolf, Boston, Mass.

928,758. PNEUMATIC ATTACHMENT FOR MORTISING-MACHINES. Elmer E. Houghton, Birmingham, Ala.

928,775. AIR-MOVER. August Mathis, Chicago, Ill.

928,837. DUMPING-CAR. Carl P. Astrom, Hasbrouck Heights, N. J.

928,867. TREATMENT OF ACETYLENE GAS. Joseph H. James and Herbert Watson, Pittsburg, Pa.

1. The method of treating acetylene gas for storage, which consists in mixing together and compressing acetylene gas with the vapor of acetaldehyde, substantially as described.

JULY 27.

928,953. AIR-SEPARATOR. George S. Emerick, Nazareth, Pa.

928,970. DUPLEX-PRESSURE EMERGENCY-BRAKE. Theodore A. Hedendahl, Denver, Colo.

928,978. APPARATUS FOR REGENERATING VITIATED AIR. George F. Jaubert, Paris, France.

929,033. FLUID-PRESSURE VALVE. Jonathan M. Sissons, Cranbrook, British Columbia, Canada.

929,055. PRESSURE-GOVERNING APPARATUS. Walter V. Turner, Edgewood, Pa.

929,066. PNEUMATIC CLEANING IMPLEMENT. David T. Williams, Paterson, N. J.

929,092. HUMIDIFIER. James Kelly, Providence, R. I.

929,111. FLUID-OPERATED TOOL. Charles B. Richards, Cleveland, Ohio.

929,113. VACUUM MASSAGING - MACHINE. Charles B. Rider, Ocean City, N. J.

929,150. MILK-CAN. George H. Marting, Columbus, Ohio.

929,217. AEROPLANE. Oscar Heeren, Paris, France.

929,264. AUTOMATIC SPEED-REGULATOR FOR PNEUMATIC MOTORS. Joseph Wieser, St. Johnsvile, N. Y.

929,343. SPRAYING APPARATUS. Frank Swearingin, Batchtown, Ill.

929,351. PNEUMATIC TIRE. Paul I. Viel, Paris, France.

929,378. AIR-SHIP. Charles J. Berthel, Pinetown, N. C.

929,401. AIR-COMPRESSING PUMP. Sven Dahlberg, Springfield, Mass.

929,429. PNEUMATICALLY-OPERATED IGNITION DEVICE FOR GAS-ENGINES. Charles G. Hess, Center, Colo.

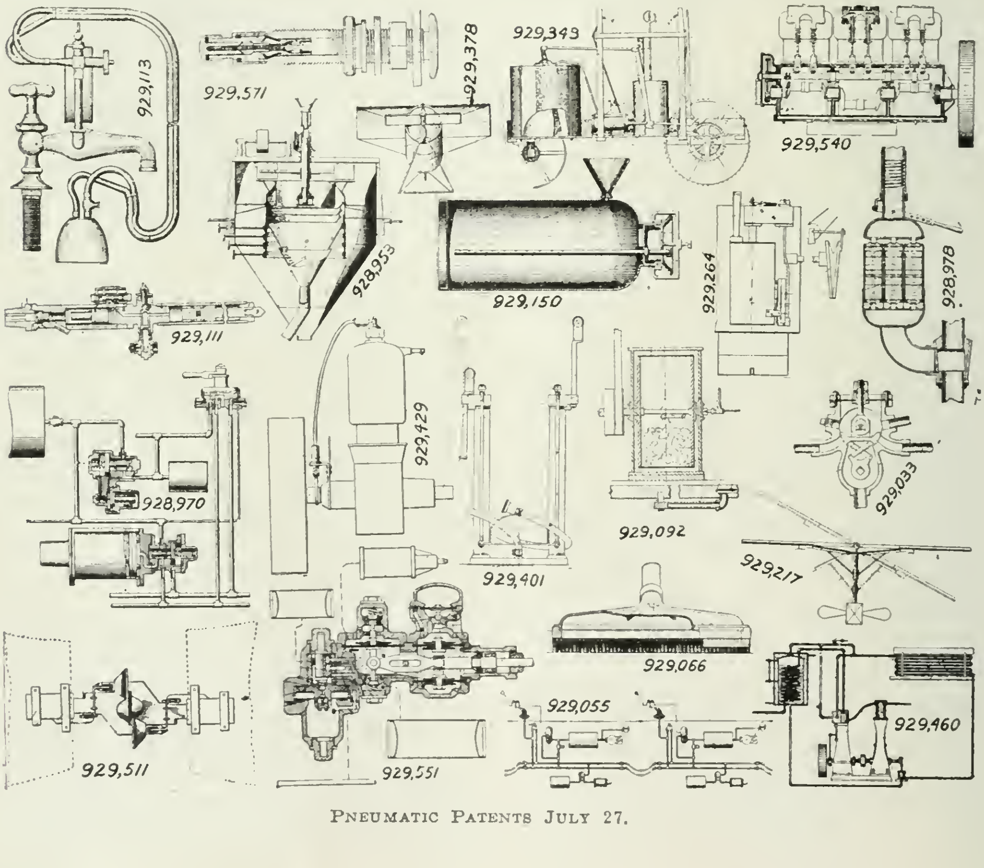
929,460. DEVICE FOR UTILIZING THE HEAT OF GASES DISCHARGED FROM COMPRESSORS. Frank P. Moran, Cincinnati, Ohio.

929,511. AUTOMATIC AIR-COUPLING. Alexander E. Squyars, Laurinburg, N. C.

929,540. REVERSIBLE PETROLEUM AND COMPRESSED-AIR MOTOR. Marius Berliet, Lyon, France.

929,551. ACCELERATOR FOR CONTINUOUS PNEUMATIC BRAKES. Francois J. Chapsal, and Alfred L. E. Saillot, Colombes, France.

929,571. VALVE FOR PNEUMATIC TIRES. Edouard Dubied, Couvet, Switzerland,



Pneumatic Patents July 27.

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC.

Vol. XIV OCTOBER, 1909 No. 10

AIR RECEIVER PRACTICE

By Frank Richards.

Among the practical details of compressed-air practice, the function of the air receiver has perhaps received less than its proper share of attention. Recent consideration of its use in these columns has been interesting and profitable and suggests some further discussion.

Usually every compressor is provided with a receiver or air reservoir, and almost invariably it is placed quite near the compressor. I am beginning to ask myself why the air receiver is considered such a necessary adjunct, why, if used, it is located so near the compressor, and some other questions implied by these.

As a reservoir for the storage of the air and for the maintenance of the pressure when the compressor stops, or when temporarily the demand for air exceeds the capacity of the compressor, it is of little account, since usually the total capacity of the receiver does not exceed one minute's output of the compressor with which it is connected. When the air is being used as fast as it is compressed, if a sudden stoppage of the compressor occurs the pressure falls so quickly that it is usually too low for efficient service in half a minute or less. The air in long pipe lines of ample capacity will, of course, extend the time somewhat, but it is always found that when the air is used for constantly working tools, or other apparatus, the storage feature is not much to be counted on.

An experience which came early to the first extensive users of compressed air, the rock-drill runners, was with the trouble and delay caused by the freezing up of the exhaust passages of the drills. This freezing up was ultimately realized to be a result not alone of the fall of temperature of the air as it expanded in doing work, but was due also to the presence of released moisture in the air, which moisture could be deposited and frozen in accumulating masses in the exhaust passages. The freezing temperature alone could not make trouble of the kind that was actually encountered. If there is no free moisture to be deposited and frozen, there can be no choking up. This freezing up is generally more cheaply and effectively prevented by the elimination of the moisture than by maintain-

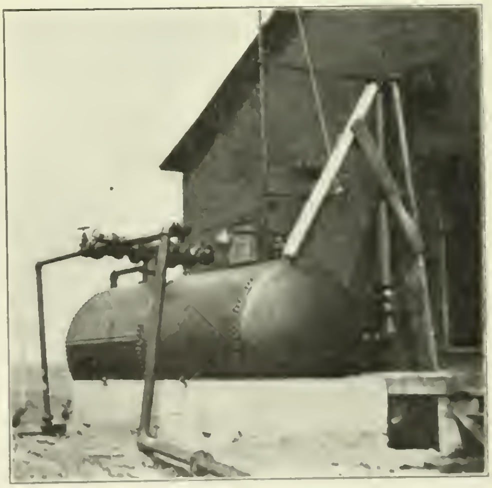


FIG. 1.

ing the temperature of the air above the freezing point. This is not in any way belittling the value or importance of air reheating. The desirability of having dry compressed air is generally realized, and it is commonly understood that the real and most important service of the air receiver is to give the air an opportunity to drop its superfluous moisture before it is delivered to its work, it being assumed that the air will most accommodatingly do this in the receiver, which is, therefore, provided with a drip cock, from which it is expected that the water is to be drawn. Generally speaking, it may be said that the air which passes through an air receiver as ordinarily installed does not emerge in a very dry state. In Fig. 1 is shown a horizontal air receiver connected to a motor-driven compressor used on one of the New York State barge canal contracts. It may be said incidentally that, from a mechanical-engineering point of view, everything connected with this compressed-air installation is excellent. The piping and all accessories are perfect. Air leakage and such troubles are impossible here, and the cost of maintenance of the plant is a minimum.

The air from the compressor passes into the receiver at the side near one end, and out at the top, near the other end. As the air enters the receiver with the heat of the final compression, and as, after the receiver once gets as hot as the air, there is nothing in the receiver to cool the air and it passes out at about the same temperature as when it enters. From the location of the inlet and outlet pipes we may well assume that when the compressor is running, the entire contents of the receiver are in motion, and it would be rather absurd to assume that the air is appreciably cooler at one point of the receiver than at another. With a temperature above 300 degrees Fahrenheit, there would be no apparent reason why there should be a difference of a single degree, or why, so far as temperature was concerned, the air might not be taken from one part of the receiver as well as from any other.

Nor would it make any difference, so far as the deposition of moisture in the receiver was concerned, where the outlet was located, because practically all the moisture in the air would be carried along with it, and out of the receiver in any case. It is a fact that there is a drain cock provided at the farther end of this receiver, and also while the man in charge perfunctorily opens the cock every few days there is no water there to be drawn off.

In Fig. 2 is shown a vertical air receiver connected to two steam-driven air compressors at lock 7, on the barge canal. The air enters near the top of the receiver and passes out to the distributing pipes near the bottom. There is little practical advantage shown by this arrangement over that of the horizontal receiver connected as in Fig. 1, and if the connections were reversed or otherwise arranged very little water would accumulate in the receiver in any case.

That there is moisture in the air, and carried along with it when leaving the receiver, is evident, as in case the air has passed through a quarter of a mile of pipe and has become cooled to normal temperature while still under full pressure in the pipes, water will be found; and with any suitable opportunity here provided for the water to collect, and with means for drawing it off, considerable quantities may be obtained.

When compressed air is at its highest pressure, and at its lowest temperature, its capacity for moisture is at the minimum, and cold compressed air, which is at the point of saturation, would pass for dry air when expanded to atmospheric pressure and reheated. It is for securing this desired condition of low temperature with high pressure that the aftercooler has its value in connection with the air receiver. While there is little or no deposition of moisture in the air receiver as generally used, with only hot air passing through it, the case is very different if the air is thoroughly cooled before the receiver is reached, the receiver then becoming a water collector.

An interesting and uptodate compressor plant, the designers of which have given evidence of recognizing and appreciating the things which are worth while in compressed-air practice, is that which has been installed at High Falls, Ulster county, N. Y., for the work of construction of the Rondout siphon in the Catskill extension of the New York City water supply. In the power house there are ten compressors, with a combined capacity of 24,000 cubic feet of free air per minute. One feature of this plant is the employment of aftercoolers for the entire system. For each pair of compressors there is the usual air receiver. Conveniently near, but close to each vertical air receiver there is also a vertical aftercooler, through which the air from the compressors must first pass and be thoroughly cooled before entering the receiver. In this case we can fully understand that the air in the receivers will be in condition to drop its superfluous moisture, and there can be little doubt that considerable quantities of water will be drawn from those receivers, and that the air when it comes to be used will be so "dry" that no inconveniences will later accompany its use.

I have to confess, however, that even the arrangement of the aftercoolers thus combined with and preceding the receivers does not promise complete success in the drying of the air. In the receivers here spoken of there would certainly be opportunity for discussion as to the best points of location for both inlet and outlet, but more than that is required to be considered.

To induce the air to drop as much of its moisture as possible, not only must we have the highest pressure and the lowest temperature occurring simultaneously, but we must also give the air *time* for the completion of the deposition of the released moisture.

I was at one time foreman of a shop extensively manufacturing pulleys, shafting, hangers, etc., especially pulleys, and I introduced a machine for grinding the faces of the pulleys instead of turning them. Of course the grinder made lots of dust which was effectively taken care of, so far as the machine was concerned, by an exhaust fan which was an integral part of the apparatus, but the disposal of the dust-laden air was a problem.

It happened that the proprietor of the works was often afflicted with novel and brilliant ideas, and one of them struck him in this connection. The tall brick boiler stack of the works was only a few feet from the grinder, and a pipe carrying the discharge from the fan was led into it, sending all the dust up into the sky with the smoke. Could anything be simpler? Unfortunately many people lived in the immediate neighborhood and on the first washday the dust was heard from. The white clothes on the lines were covered with yellow spots of iron rust, and the exhaust into the stack had to be suddenly abandoned.

We then went through a course of experimenting to find some way of getting the dust out of the air so that it would not make trouble. The exhaust pipe of the fan was only 3 inches in diameter, and we made a vertical box a foot square and of considerable height with shelves occupying half the area, about a foot apart vertically and placed alternately on opposite sides of the box, so that the air could zig-zag back and forth and deposit the dust on the shelves; which it didn't do to any extent. The same box was tried in a horizontal position with no better results, and other trials, of which these may be taken as typical, were no better.

FIG. 2.

The ultimate solution was simple enough We finally realized that if the air moved slowly enough, the dust, or most of it, would drop through the air of its own weight and settle along the way The air was discharged into one end of a horizontal box or chamber 4 feet square, and here it dropped the dust so that it could be shoveled out at openings provided, while the air passed out through a large opening near the top at the other end and was never after heard of

The moisture in air, being always present, is, we might say, a part of the air, and until the point of saturation is reached the air remains transparent, and it is more ready to absorb more moisture as it finds the opportunity than it is to give it off. When its moisture capacity is so reduced by changes of pressure or temperature, especially the latter, as to cause it to be oversaturated, then the excess of moisture is condensed into water and forms a cloud distributed through the air, the cloud consisting of minute drops or particles of actual water, those portions of water being then heavier than the air and being sustained in the air just as dust is by friction, and with always a tendency to descend through the body of air by the action of gravity. Give the water in the air sufficient time, and it will drop to the bottom of the channel or pipe through which the air flows, when it can be drawn off.

In the air receiver as usually installed even if all the other conditions for drying the air are secured, there usually is not enough time allowed for the released water to drop out. It would seem that if the cost of the receiver, the aftercooler being assumed, was all put instead into the enlargement of sufficient lengths of horizontal pipe, at the beginning of the line thus forming a long horizontal receiver through which the air could flow with the requisite slowness, drier air would be delivered.—*Power and the Engineer.*

THE WATER WE BUY AND EAT

The following is the percentage of water in some of the familiar articles of food:

Uncooked beef or mutton	75
Lamb	64
Pork	50 to 60
Smoked bacon	22
The flesh of pigeons	70
Fowls and Ducks	70
A fat goose	38
Fish range from	40 to 80
Milk fresh from the can	86 to 88
Apples	80 to 82
Strawberries	90
Grapes	80
Turnips	90
Cabbages	90

Cucumbers, vegetable marrows and pumpkins are 95 per cent. water, or contain not more than half the solid matter found in milk.

A MOVABLE CAISSON FOR SUBMARINE WORK

BY THE GERMAN CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

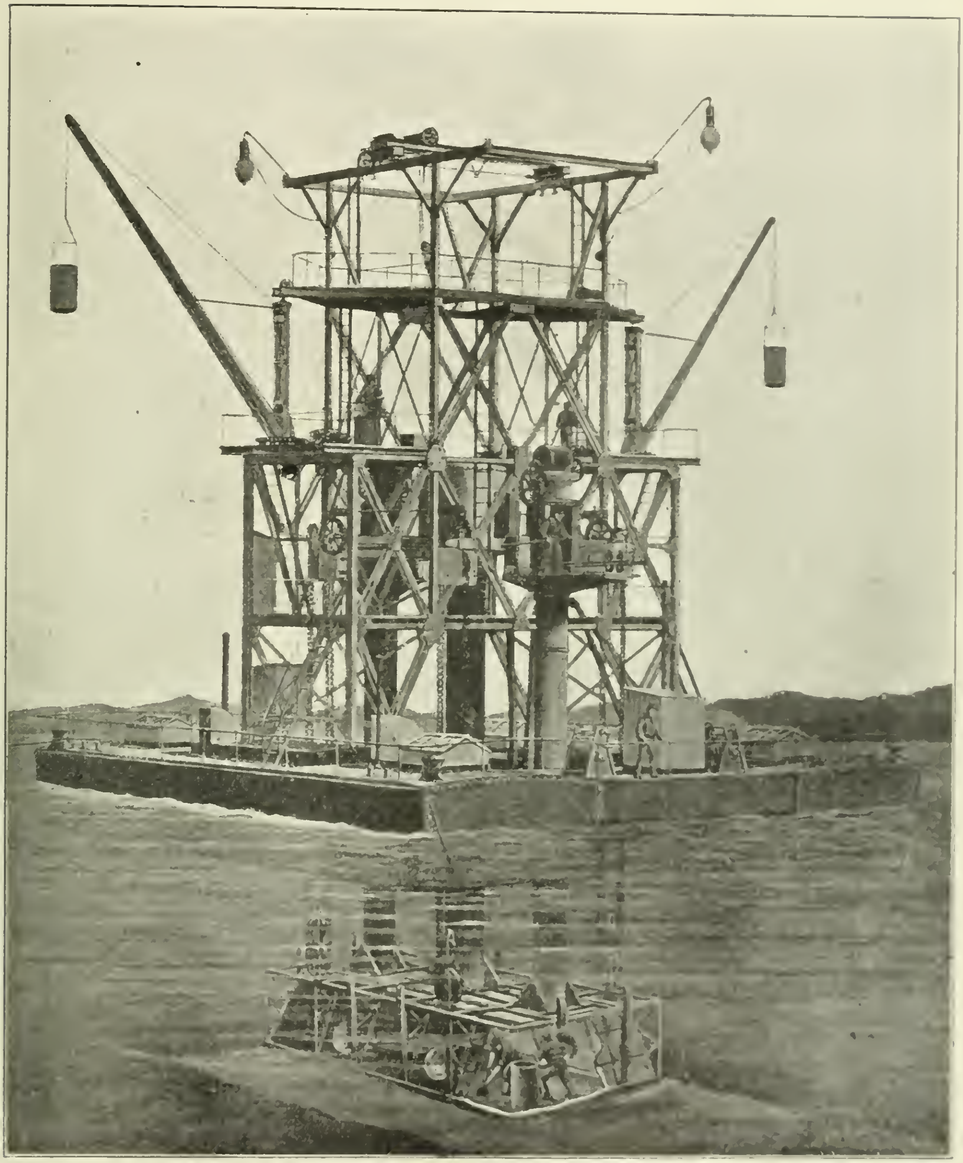
A remarkable diving bell or portable caisson has recently been constructed for the German Navy Department for use in the deepening of the harbor of its naval base at Tsingtau. The remarkable features are not so much those of the bell itself, but of its connection with the imposing structure above water shown in the half-tone, the whole making a complete and self-contained unit for excavating to a maximum depth of 15 meters (49 ft) below water level.

Two pontoons, each 54 feet long, 18 ft wide, and 7.2 ft. deep, are rigidly braced together bow and stern, forming between them a well up into which the diving bell may be completely withdrawn from the water. Upon the deck of the joined pontoons is erected the superstructure, from which the diving bell is suspended and operated, consisting principally of conventional I-beams and angles.

The diving bell is built of sheet iron, externally braced, and is 33 ft. long, 16 ft. wide, and 8.2 ft. high. Extending upward from the top of it are three telescopic shafts, two for the hoisting of the excavated material, each 31.5 in. in diameter, through which a bucket of 1 ton capacity can pass, and one of 39 in. diameter for the workmen. Each of these is provided with such an "air lock" as is now familiar in connection with tunnel and foundation work in New York and elsewhere, in which, as workmen enter, the air pressure is gradually raised from that of the atmosphere to that required to exclude water and mud from the interior of the caisson, being similarly reduced for those ascending from work. The air locks of the spoil shafts are identical, but the air may be compressed or exhausted much more rapidly in the hoisting of buckets of excavated material, the gradual change of pressure being necessary in the case of men only as a precaution against caisson disease.

The bell is suspended by four sets of chain tackle, one at each corner, which are mounted on opposite ends of two shafts on the operating platform of the superstructure, driven simultaneously by an electric motor when it is desired to raise or lower the bell.

Higher platforms carry two cranes, which receive the buckets of excavated material from



EXCAVATING APPARATUS WITH PORTABLE CAISSON.

the top of the spoil shafts and deliver them into scows, alongside or however desired, the cranes also being electrically driven, as are the winches inside the spoil shaft for hoisting the buckets from the interior of the bell. One man on the platform at the top of each of the latter can hoist the bucket with the winch, detach it, hook it onto the crane, and *vice versa* and also raise and lower the bell as desired. Two more operators for the cranes above are required.

On the deck are three compressors supplying the necessary air pressure to the interior of the bell, electric power for the whole equipment being supplied from a stationary plant on shore. Both the superstructure and the interior of the bell are electrically lighted, and communication is maintained between them and from either to the shore by telephone. Quarters for the crew are provided in the interior of the pontoons.

The design of the superstructure permits of continuous operations being carried on independently of the varying height of the pontoons due to rise and fall of tides.

THE STORY OF GUNNISON TUNNEL

One of the latest of the world's great beneficent, yet strictly business, enterprises owing its inception and completion to the agency of compressed air is the Gunnison tunnel in Southwestern Colorado, which before these lines greet the reader will have begun its career of reclamation of a vast acreage of "a land that God forgot." It will lead a river through a mountain, and the waters will transform a region of 200,000 to 300,000 acres of volcanic dust into farming land of high productivity. This is the foremost of thirty-two irrigation projects which the United States government has at present in hand.

The story of the inception of this vast enterprise and the carrying it to completion is told in a recent issue of the New York *Times* in an article typical of the excellent work which is being done by the great dailies of the Metropolis. What follows is mostly an abstract of the article referred to, and it is much to be regretted that the personality of the author is not revealed.

The Uncompahgre River, which gives its name to the valley also, has its source in the everlasting snows of Mount Wilson, fifty or sixty miles to the south, and flows into the Grand Canon of the Colorado forty miles to the northwest beyond the prosperous town of Grand Junction. The river does duty all along its course in irrigating the adjoining land, but its volume of water is not sufficient for the needs of more than a small fraction of the entire valley.

Many years ago one of the oldest settlers of the valley, John Hammond, while hunting up over the divide, where he could look far down, thousands of feet, into the Canon of the Gunnison, found himself wishing that he had that mass of water over on his land in the Uncompahgre Valley. The thought stayed with him. He told his neighbors, and wrote to the Denver papers about it. To him first came the thought of the tunnel. Riding up and down the valley, going out Fall and Spring for his supplies, wherever he could find any one to listen to him he delivered his incessant argument for the Gunnison Tunnel. As the years went by other people took up the same argument, and in time it came to be one of the local issues of the western part of Colorado, and Hammond was sent to the Legislature as its proponent. He wasted no time and succeeded to the extent of passing a bill appropriating $25,000 for his beloved project. This, of course, was a mere bagatelle, about enough to make it a joke.

But in time the little group of irrigating Congressmen in Washington grew stronger until their caucus developed strength enough, with the powerful aid of President Roosevelt, to dictate the passage of the Reclamation Act of 1902. Now Hammond's chance really came. Through his Senators and Congressmen and by personal letter, and through the combined efforts of the whole region, the Government was petitioned to take up the project.

One day Chief Engineer Newell of the Reclamation Service sent the following telegram to the resident engineer of the service at Denver: "Advise me if it is feasible to construct a tunnel under Vernal Mesa to carry the waters of Gunnison River to Uncompahgre Valley." With this the great undertaking began, so far as the Government was concerned. It meant that a survey must be made of the huge Black Canon of the Gunnison, through which no human being had ever gone. None but birds had crossed it; no living thing had ever come from its yawning depths to tell what was within. For many miles the waters of the Gunnison, beaten to foam, went roaring, 3,000 feet deep down in the earth through a narrow channel less than 100 feet wide.

There is seldom greater bravery shown than was displayed by the two civil engineers of the Reclamation Service who undertook to make the survey of the Black Canon. These were Mr. A. L. Fellows, the resident engineer, and Mr. W. W. Torrence, the assistant engineer. Climbing up over the Mesa, they made ready to descend 2,500 feet over the rock walls to the surface of the stream. In many places the descent was a sheer precipice, and they had to let themselves down by ropes. They carried only a rubber mattress, six days' food, scantily measured for the work they had to do, and their surveying instruments. For twelve days they lived down in that huge chasm, where the light of the sun came but dimly for a few hours of the twenty-four, and never shone with unobstructed sunlight except at a few places in line with the meridian north and south.

Only here and there were there rocks or anything like a footing to stand on. Most of the time they were traveling in the water clinging to slippery rocks, swimming rapids, and forever in fear of the treachery of the merciless stream. Hardly a place was found at nightfall where they might go shivering to sleep. Their food was soon wet and spoiled, and it became a gnawing question whether they would get out alive. They lost their instruments and most of their clothes. Most of their journey through the canon was made by swimming in the cold waters of the Gunnison, but through it all they were mindful more of the great work that had been intrusted to them than they were of their personal comfort or even their lives. They made the observations and took the notes they were sent to get, and these were about all they brought out with them when at the end of twelve days they emerged at the mouth of Devil's Slide almost naked, worn out in body and mind, and pale and sick with hunger. The first thing they did was to make haste to the nearest telegraph office and send a short telegram of five words to Chief Newell in Washington: "The Gunnison tunnel is feasible."

After Fellows and Torrence made their survey and reached their eternally famous decision that the Gunnison tunnel was feasible, it was not long before orders went out from Washington to dig. This was in 1905. The tunnel was begun, one end in the gorge and the other from the edge of the valley. Miles of road had to be built to carry in machinery and supplies for the work. On the 6th of July, 1909, the shifts of men at work in each end section of the tunnel heard the last round of shots that broke the last remaining rock, and the two ends met.

So accurate were the surveys that the sides of the tunnel met within 12-100 of a foot and the top within 65-100 of a foot. The tunnel itself is six miles long; its cross-section is 10 feet 6 inches by 11 feet 6 inches and its capacity is 1,300 cubic feet of water per second. Its entire length is lined with cement, and at the outlet on the valley side it connects with a ditch twelve miles long, wider and deeper than the Erie Canal. This canal carries the entire volume of the Gunnison River taken for irrigation, winding around the adobe hills, gradually down to the level of the valley, to be distributed through a grand system of canals over a distance of forty miles.

In the four years it took to blast out the Gunnison tunnel many thrilling experiences came to the men engaged in the work. It was a long and tireless task, boring through the eternal fastnesses of that huge mountain. For the most part the rock is volcanic in character of the Archaic period, tough and obdurate. Yet there were adventures along the route. A few times there were lucky finds in the way of nuggets of gold. Several times they encountered streams of hot water, but more often streams of cold water, some of them highly mineral in character. Sometimes following the heavy blasts millions of gallons of water rushed in upon the workmen, who had to battle for their lives. Near the valley end of the tunnel an old ocean bed was found, and in the rock counless numbers of sea shells of different sizes. Through this rock the work was very dangerous and required constant timbering. In the Spring of 1905 the drills ran into an underground stream which caused a cave-in, and for forty-eight hours a number of workmen were buried alive. A shaft was sunk from the outside and the men were saved. Numbers of men that were caught in the cave-in were pinned down by rocks, but those who were free to work had shoveled up dikes to keep the water away from their injured comrades, and thus saved their lives.

There is very little Government land in the Uncompahgre Valley that will be available for homesteads when the water reaches it. Of the 150,000 acres that will be immediately under water about 15,000 are still in the public domain, withdrawn from entry. The rest is deeded land, most of it easily put under cultivation. Lands now under cultivation are worth anywhere from $35 to $50 an acre. This is land with some water, but not enough There are many thousands of acres in the valley planted to prosperous orchards. The soil and the air of the region have precisely the virtues that give fruits of all kinds fine flavor and beautiful color The fruit pours out of the valley in the Fall by hundreds of carloads, and in some years' competition for its purchase is so great that Colorado enjoys but little of it, most of it going to Chicago and the East. Of this fine, rich land, whose soil is practically unlimited in depth, the average farmer needs but little. Forty acres is a large farm; twenty acres is sufficient for the average husbandman. Besides fruit, the farmer can get rich on alfalfa, which he can cut three times in a season and which yields him from five to seven tons altogether. Vegetables of every description grow to perfection. The finest strawberries are easily raised under irrigation. Sugar beets and potatoes, wheat, oats, and rye are easily raised. The altitude is from 5,000 to 6,000 feet, and corn is not entirely at home, but that does not matter where alfafa can be produced so abundantly. It is a land where dairying may easily be developed, and with the abundant alfafa bloom the busy bee can make mountains of honey.

The source whence the Gunnison derives its volume of water is the snowclad summits of the mountains. The watershed area embraces 3,850 square miles, and the estimated "run-off" of the watershed is 1,500,000 acre-feet. The rainfall over the valley annually is from six to twelve inches, and over the watershed from seven to twenty inches. The average size of the farms under this project will be about forty acres. Of the entire area it is estimated that 60,000 acres are available as first-class soil for apples and peaches. There are now orchards in the valley producing as high as $500 per acre net per annum. The alfalfa farmers, who will have about 80,000 in the bottom land, will not reap so great a return, but they will make as much as $60 to $80 per acre from either alfalfa or sugar beets, and can do even better with potatoes. The great beauty of the soil of the region is that it seems to be very happily balanced in plant food, with just the right proportion of potash, phosphate, and nitrogen. Very few weeds are to be encountered because the region has been a dry one, and the vegetation exceedingly sparse hitherto. It will be several years, however, before the entire region is gradually brought under water, as the system of main canals in the distributing district calls for 180 miles of canal digging. Of the thirty-two irrigation projects undertaken by the Government the Gunnison Tunnel is perhaps the most marvelous and in results it will doubtless measure up with the largest.

CHARGING AIR CHAMBERS OF PUMPING ENGINES

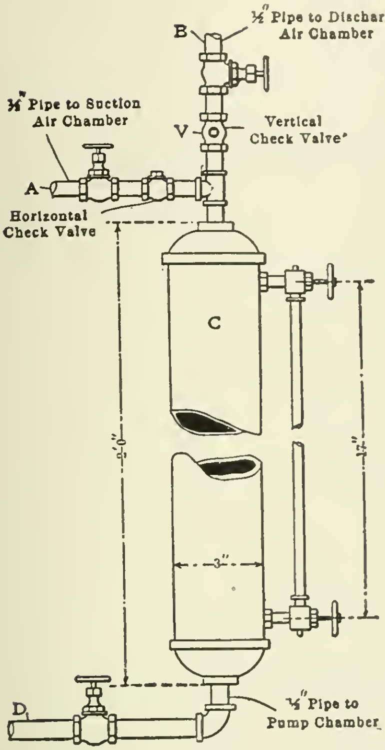
In operating pumping engines it is generally necessary to provide means of supplying air under pressure to the air chambers, particularly those on the discharge pipes, as, through leaks in the piping or by absorption or entrainment in the rapidly moving water, the air gets away and must be replaced if the pump is to work smoothly.

It is generally customary to provide an air compressor of some kind; many plants use the direct-acting air-brake type, which is very compact and convenient. When the water is taken from a well or a pond, by a pump located considerably above the surface of the water, advantage may be taken of the fact that the pressure in the pump chamber of a reciprocating pump is alternately above and below the atmospheric line to employ what is sometimes called a snifting valve, in which on the suction stroke the air is drawn into a cylinder connected by a pipe with the pump chamber, and on the discharge stroke is forced through a pipe into the air chamber, check valves on the air-suction and discharge pipes preventing the entrapped air from getting back through the suction pipe on the discharge stroke, or returning from the air chamber on the suction stroke.

In a small pumping station the water comes to the pump from a supply main serving at a pressure of about 25 pounds and is discharged by the pump against a pressure of about 145 pounds per square inch, in order to supply an elevated part of the town.

On account of the high pressure in the discharge pipe it was found very difficult to supply air to the discharge air chamber with the single-stage air compressor in use at this plant as the slightest wearing away of the piston or valves rendered the compressor useless. As the cost of a new two-stage compressor, or of adding an extra cylinder to the old machine, was considerable, a special form of snifting valve was devised which takes its air supply from a large air tank in the basement, connected to the suction main and used as a shock absorber.

As the air pressure in this tank is only 25 pounds, the single-stage compressor will put air into it with ease. An air pipe runs from the top of this tank to the suction check valve



on the snifting device attached to the water end of the pump. At an elevation of about 14 feet above the water level in the suction tank the pressure due to a column of water of this height is thus available to force the air into the snifter. The sketch shows the construction of the device, which is operated as follows:

Air from the suction tank enters at *A*, on the suction stroke, displacing the water in the cylinder *C* and forcing it into the pump chamber through the pipe *D*. On the discharge stroke, water, under 145 pounds pressure from the pump chamber, rushes into the cylinder and forces the air through the vertical check valve at *V* into the discharge air chamber.

The snifter was made at trifling expense out of an old cast-iron water column taken from an abandoned boiler. It has worked in a perfectly satisfactory manner for about a year with a considerable saving in expense and annoyance.

Experiments have been made which show that with a properly proportioned inspirator, using the high-pressure water, it is possible to draw air into the suction tank, thus dispensing entirely with the steam-operated air compressor, but as the experimental inspirator was too small to use in practice the compressor is still in service.—*Power and the Engineer.*

VOLUMES, PRESSURES AND TEMPERATURES IN THE ADIABATIC COMPRESSION OF AIR

By Frank Richards.

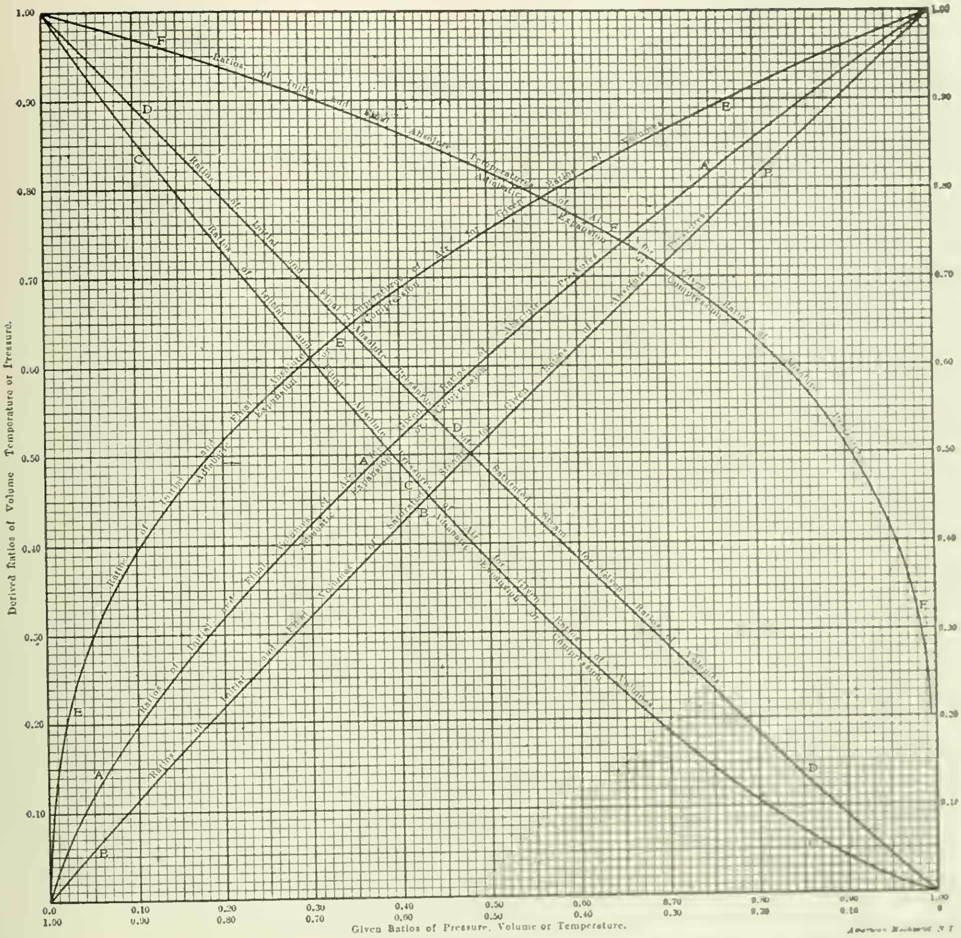
The table and chart herewith should be of service to the large and constantly increasing number of workers and investigators in mechanical lines who have to do with compressed air. The actual compression of air in the usual way, in cylinders having reciprocating pistons, is practically adiabatic in each specific case, and in investigating the power requirements, the actual power consumption and other conditions of such compression, it is necessary always to know and consider the pressures, volumes and temperatures involved, and for this work the table and chart here presented should prove a substantial aid.

On a little inspection of the table and diagram it will be seen that if we trace the ratio of the initial to the terminal (or *vice versa*) of either the pressures, the volumes or the temperatures of air, compressed and delivered without loss or gain of heat (adiabatic compression), the ratios of the other two particulars are easily determined, and then having the ratio in either case, with the pressure, volume, or temperature at either the beginning or the termination of the act of compression (or expansion), the corresponding pressure, volume or temperature for the other end of the operation also will be known.

Our first and most easily accessible knowledge of any specific operation of compression is as to the pressures at the beginning and at the end of the compression. Thus, say that we are working at or near sea level, or taking in the air at an absolute pressure of 14.7 pounds and delivering the air at 80 pounds gage, the absolute pressure then, of course, being 80+14.7=94.7 pounds, the ratio of initial to terminal pressure will be 14.7÷94.7=0.1552. With these pressures at the opposite ends of the stroke the ratio will, of course, be the same whether compressing the air in the ordinary reciprocating compressor or expanding the air in doing work in an air engine

Ratio.	Reciprocal.	A	Reciprocal.	B	Reciprocal.	C	Reciprocal.	D	Reciprocal.	E	Reciprocal.	F	Reciprocal.
0.01	100	0.0380	26.315	0.0131	76.259	0.0015	666.66	0.0075	133.33	0.1528	6.544	0.2633	3.799
0.02	50	0.0621	16.103	0.0252	39.682	0.0041	243.90	0.0157	63.69	0.2027	4.933	0.3219	3.106
0.03	33.33	0.0829	12.062	0.0369	27.102	0.0072	138.88	0.0241	41.49	0.2392	4.180	0.3620	2.762
0.04	25	0.1017	9.832	0.0483	20.704	0.0108	92.592	0.0327	30.58	0.2689	3.718	0.3935	2.541
0.05	20	0.1191	8.396	0.0596	16.778	0.0147	68.027	0.0414	24.15	0.2946	3.394	0.4198	2.382
0.06	16.66	0.1356	7.374	0.0708	14.039	0.0190	52.631	0.0503	19.88	0.3173	3.151	0.4425	2.259
0.07	14.28	0.1513	6.609	0.0819	12.210	0.0237	42.194	0.0593	16.86	0.3379	2.959	0.4627	2.161
0.08	12.5	0.1663	6.013	0.0928	10.775	0.0286	34.964	0.0683	14.64	0.3568	2.803	0.4810	2.079
0.09	11.11	0.1808	5.531	0.1037	9.643	0.0337	29.675	0.0774	12.92	0.3744	2.671	0.4977	2.009
0.10	10	0.1949	5.131	0.1145	8.733	0.0391	25.575	0.0866	11.54	0.3908	2.558	0.5131	1.948
0.11	9.091	0.2085	4.796	0.1253	7.981	0.0447	22.371	0.0958	10.43	0.4063	2.461	0.5275	1.895
0.12	8.333	0.2218	4.508	0.1359	7.358	0.0505	19.802	0.1051	9.522	0.4210	2.375	0.5410	1.848
0.13	7.692	0.2348	4.259	0.1466	6.821	0.0566	17.668	0.1144	8.741	0.4350	2.298	0.5537	1.806
0.14	7.143	0.2475	4.040	0.1572	6.361	0.0628	15.923	0.1238	8.077	0.4484	2.230	0.5657	1.767
0.15	6.667	0.2599	3.847	0.1677	5.963	0.0692	14.451	0.1332	7.507	0.4612	2.168	0.5771	1.732
0.16	6.25	0.2721	3.675	0.1782	5.611	0.0758	13.192	0.1427	7.007	0.4735	2.112	0.5880	1.700
0.17	5.882	0.2841	3.519	0.1887	5.299	0.0825	12.121	0.1522	6.570	0.4853	2.066	0.5984	1.671
0.18	5.556	0.2959	3.380	0.1991	5.022	0.0894	11.185	0.1617	6.188	0.4968	2.012	0.6084	1.643
0.19	5.263	0.3074	3.253	0.2095	4.773	0.0965	10.362	0.1713	5.837	0.5079	1.968	0.6180	1.618
0.20	5	0.3188	3.136	0.2199	4.547	0.1037	9.643	0.1809	5.527	0.5186	1.930	0.6273	1.594
0.21	4.762	0.3301	3.029	0.2302	4.344	0.1111	9.001	0.1905	5.249	0.5290	1.890	0.6362	1.571
0.22	4.545	0.3412	2.930	0.2405	4.157	0.1186	8.431	0.2001	4.997	0.5392	1.854	0.6448	1.551
0.23	4.348	0.3521	2.840	0.2508	3.987	0.1263	7.917	0.2098	4.766	0.5490	1.821	0.6532	1.530
0.24	4.167	0.3629	2.755	0.2610	3.831	0.1341	7.457	0.2195	4.555	0.5586	1.792	0.6613	1.512
0.25	4	0.3736	2.676	0.2712	3.687	0.1420	7.042	0.2293	4.361	0.5680	1.760	0.6692	1.494
0.26	3.846	0.3841	2.603	0.2814	3.553	0.1501	6.662	0.2390	4.182	0.5772	1.732	0.6768	1.477
0.27	3.704	0.3946	2.534	0.2916	3.429	0.1583	6.317	0.2488	4.019	0.5861	1.706	0.6843	1.461
0.28	3.571	0.4049	2.469	0.3018	3.313	0.1666	6.000	0.2586	3.867	0.5949	1.681	0.6915	1.446
0.29	3.448	0.4151	2.409	0.3119	3.206	0.1750	5.701	0.2684	3.725	0.6035	1.657	0.6986	1.431
0.30	3.333	0.4252	2.351	0.3220	3.105	0.1836	5.446	0.2783	3.593	0.6119	1.634	0.7055	1.417
0.31	3.226	0.4353	2.297	0.3321	3.011	0.1922	5.203	0.2881	3.471	0.6201	1.611	0.7122	1.404
0.32	3.125	0.4452	2.246	0.3422	2.922	0.2010	4.975	0.2980	3.355	0.6282	1.591	0.7188	1.391
0.33	3.03	0.4550	2.197	0.3522	2.839	0.2099	4.764	0.3079	3.247	0.6361	1.572	0.7252	1.378
0.34	2.941	0.4648	2.151	0.5623	2.760	0.2189	4.568	0.3178	3.146	0.6439	1.553	0.7815	1.365
0.35	2.857	0.4744	2.108	0.3723	2.686	0.2281	4.384	0.3278	3.050	0.6516	1.534	0.7377	1.355
0.36	2.778	0.4840	2.066	0.3823	2.615	0.2373	4.214	0.3377	2.961	0.6591	1.517	0.7438	1.344
0.37	2.703	0.4935	2.026	0.3923	2.549	0.2466	4.055	0.3477	2.876	0.6665	1.500	0.7497	1.333
0.38	2.632	0.5030	1.988	0.4023	2.485	0.2561	3.904	0.3577	2.795	0.6738	1.484	0.7555	1.323
0.39	2.564	0.5124	1.949	0.4122	2.426	0.2656	3.765	0.3677	2.719	0.6810	1.468	0.7612	1.313
0.40	2.5	0.5216	1.917	0.4222	2.368	0.2752	3.633	0.3777	2.647	0.6881	1.453	0.7668	1.304
0.41	2.439	0.5309	1.883	0.4321	2.314	0.2850	3.509	0.3878	2.578	0.6951	1.438	0.7723	1.294
0.42	2.381	0.5400	1.851	0.4420	2.262	0.2948	3.392	0.3978	2.513	0.7019	1.424	0.7777	1.285
0.43	2.326	0.5491	1.819	0.4519	2.212	0.3047	3.281	0.4079	2.451	0.7087	1.411	0.7831	1.276
0.44	2.273	0.5582	1.791	0.4618	2.165	0.3148	3.176	0.4180	2.392	0.7154	1.397	0.7883	1.268
0.45	2.222	0.5672	1.763	0.4716	2.122	0.3249	3.084	0.4281	2.336	0.7220	1.385	0.7934	1.260
0.46	2.174	0.5761	1.735	0.4815	2.076	0.3351	2.984	0.4382	2.282	0.7285	1.372	0.7985	1.252
0.47	2.128	0.5850	1.709	0.4913	2.035	0.3454	2.895	0.4483	2.230	0.7349	1.360	0.8035	1.244
0.48	2.083	0.5938	1.684	0.5012	1.979	0.3558	2.810	0.4585	2.181	0.7412	1.349	0.8084	1.237
0.49	2.041	0.6025	1.659	0.5110	1.957	0.3663	2.730	0.4686	2.134	0.7475	1.337	0.8133	1.229
0.50	2	0.6112	1.636	0.5208	1.920	0.3768	2.654	0.4788	2.091	0.7537	1.326	0.8180	1.222
0.51	1.961	0.6199	1.613	0.5306	1.884	0.3875	2.581	0.4890	2.045	0.7598	1.316	0.8227	1.215
0.52	1.923	0.6285	1.591	0.5404	1.850	0.3982	2.511	0.4992	2.003	0.7658	1.305	0.8274	1.208
0.53	1.887	0.6371	1.568	0.5502	1.817	0.4091	2.443	0.5094	1.963	0.7718	1.295	0.8320	1.201
0.54	1.852	0.6456	1.549	0.5599	1.786	0.4200	2.381	0.5196	1.924	0.7777	1.285	0.8365	1.195
0.55	1.818	0.6540	1.529	0.5697	1.755	0.4310	2.320	0.5298	1.887	0.7836	1.276	0.8409	1.189
0.56	1.786	0.6625	1.509	0.5794	1.725	0.4420	2.262	0.5401	1.851	0.7893	1.266	0.8453	1.183
0.57	1.754	0.6708	1.491	0.5892	1.697	0.4532	2.206	0.5503	1.817	0.7951	1.257	0.8497	1.177
0.58	1.724	0.6792	1.472	0.5989	1.669	0.4644	2.153	0.5606	1.783	0.8007	1.248	0.8540	1.171
0.59	1.695	0.6875	1.454	0.6086	1.643	0.4757	2.102	0.5709	1.751	0.8063	1.240	0.8582	1.165
0.60	1.667	0.6957	1.437	0.6183	1.613	0.4871	2.051	0.5812	1.720	0.8119	1.231	0.8624	1.159
0.61	1.639	0.7039	1.420	0.6280	1.592	0.4986	2.005	0.5914	1.691	0.8174	1.223	0.8666	1.153
0.62	1.613	0.7121	1.404	0.6377	1.568	0.5101	1.960	0.6018	1.661	0.8228	1.215	0.8706	1.148
0.63	1.587	0.7203	1.388	0.6474	1.544	0.5218	1.910	0.6121	1.633	0.8282	1.207	0.8747	1.143
0.64	1.563	0.7284	1.372	0.6570	1.522	0.5335	1.874	0.6224	1.606	0.8335	1.199	0.8787	1.138
0.65	1.538	0.7364	1.358	0.6667	1.500	0.5452	1.835	0.6327	1.580	0.8388	1.192	0.8827	1.132
0.66	1.515	0.7445	1.343	0.6763	1.478	0.5571	1.795	0.6431	1.554	0.8441	1.184	0.8866	1.128
0.67	1.493	0.7524	1.328	0.6860	1.457	0.5690	1.757	0.6534	1.530	0.8493	1.177	0.8904	1.123
0.68	1.471	0.7604	1.315	0.6956	1.437	0.5810	1.721	0.6638	1.506	0.8544	1.170	0.8943	1.118
0.69	1.449	0.7683	1.301	0.7052	1.418	0.5931	1.686	0.6742	1.483	0.8595	1.163	0.8981	1.113
0.70	1.429	0.7762	1.288	0.7148	1.399	0.6052	1.652	0.6846	1.461	0.8646	1.156	0.9018	1.108
0.71	1.408	0.7841	1.275	0.7245	1.380	0.6174	1.619	0.6950	1.438	0.8696	1.149	0.9055	1.104
0.72	1.389	0.7919	1.263	0.7341	1.359	0.6297	1.588	0.7054	1.417	0.8746	1.143	0.9092	1.099
0.73	1.370	0.7997	1.250	0.7436	1.844	0.6420	1.557	0.7158	1.397	0.8795	1.137	0.9128	1.095
0.74	1.351	0.8075	1.238	0.7532	1.327	0.6545	1.527	0.7262	1.375	0.8844	1.130	0.9165	1.091
0.75	1.333	0.8152	1.227	0.7628	1.311	0.6669	1.499	0.7366	1.357	0.8893	1.124	0.9200	1.087
0.76	1.316	0.8229	1.215	0.7724	1.294	0.6795	1.471	0.7471	1.338	0.8941	1.118	0.9236	1.082
0.77	1.299	0.8306	1.204	0.7819	1.278	0.6921	1.444	0.7575	1.321	0.8989	1.112	0.9271	1.078
0.78	1.282	0.8382	1.193	0.7915	1.263	0.7048	1.418	0.7680	1.302	0.9036	1.106	0.9305	1.074
0.79	1.266	0.8459	1.182	0.8010	1.248	0.7176	1.393	0.7785	1.284	0.9083	1.100	0.9340	1.070
0.80	1.25	0.8534	1.171	0.8106	1.233	0.7304	1.369	0.7889	1.267	0.9130	1.095	0.9374	1.066
0.81	1.235	0.8610	1.161	0.8201	1.219	0.7433	1.345	0.7994	1.251	0.9176	1.089	0.9408	1.062
0.82	1.22	0.8685	1.151	0.8296	1.205	0.7562	1.322	0.8099	1.234	0.9222	1.084	0.9441	1.059
0.83	1.205	0.8761	1.140	0.8392	1.191	0.7692	1.300	0.8204	1.219	0.9268	1.079	0.9474	1.055
0.84	1.19	0.8835	1.131	0.8487	1.178	0.7823	1.278	0.8309	1.203	0.9313	1.073	0.9507	1.051
0.85	1.176	0.8910	1.122	0.8582	1.165	0.7955	1.257	0.8414	1.188	0.9358	1.068	0.9540	1.048
0.86	1.163	0.8984	1.113	0.8678	1.152	0.8087	1.236	0.8519	1.173	0.9403	1.063	0.9572	1.044
0.87	1.149	0.9058	1.104	0.8772	1.139	0.8220	1.216	0.8625	1.159	0.9448	1.058	0.9605	1.041
0.88	1.136	0.9132	1.095	0.8866	1.127	0.8353	1.197	0.8730	1.145	0.9492	1.053	0.9636	1.037
0.89	1.124	0.9206	1.086	0.8961	1.115	0.8487	1.178	0.8835	1.131	0.9536	1.048	0.9668	1.034
0.90	1.111	0.9279	1.077	0.9056	1.104	0.8621	1.159	0.8941	1.118	0.9579	1.043	0.9699	1.031
0.91	1.099	0.9352	1.069	0.9151	1.093	0.8757	1.142	0.9047	1.105	0.9623	1.039	0.9730	1.027
0.92	1.087	0.9425	1.061	0.9245	1.081	0.8892	1.124	0.9152	1.092	0.9666	1.034	0.9761	1.024
0.93	1.075	0.9498	1.052	0.9340	1.070	0.9029	1.107	0.9258	1.080	0.9708	1.030	0.9792	1.021
0.94	1.064	0.9570	1.045	0.9434	1.059	0.9166	1.091	0.9364	1.068	0.9751	1.025	0.9822	1.019
0.95	1.053	0.9642	1.037	0.9529	1.049	0.9303	1.074	0.9470	1.056	0.9793	1.021	0.9853	1.014
0.96	1.042	0.9714	1.029	0.9623	1.039	0.9441	1.059	0.9576	1.044	0.9835	1.016	0.9882	1.012
0.97	1.031	0.9786	1.021	0.9717	1.029	0.9580	1.043	0.9682	1.032	0.9877	1.012	0.9912	1.009
0.98	1.020	0.9858	1.014	0.9812	1.019	0.9720	1.029	0.9788	1.021	0.9918	1.008	0.9942	1.006
0.99	1.01	0.9929	1.007	0.9906	1.009	0.9860	1.014	0.9894	1.011	0.9959	1.004	0.9971	1.003
1.00	1.	1.	1	1.	1.	1	1.	1.	1	1	1.	1.	1.

TABLE OF RATIOS AND RECIPROCALS OF PRESSURE TEMPERATURE AND VOLUME IN THE ADIABATIC COMPRESSION OF AIR



Relations of Ratios of Pressure, Temperature and Volume in the Adiabatic Compression of Air

Use of Chart

In the chart the given or known ratios, from which the desired results are to be obtained, are noted horizontally on the base line and the ratio desired is then indicated by the vertical distance from the base line at the point noted to the curve of ratios required in the particular case. The curves *A*, *B* and *E* start from the left-hand corner, and the curves *C*, *D* and *F* from the right-hand corner, the base line being figured for facility of reading in either direction.

Say that we have an air compressor working at an altitude of 2000 feet above sea level compressing 900 cubic feet of free air per minute and delivering it into the receiver at 75 pounds gage pressure. The normal atmospheric pressure at 2000 feet being, say, 1.37 pounds, and the absolute delivery pressure then being $75 + 13.7 = 88.7$ pounds, the pressure ratio will be $13.7 \div 88.7 = 0.1544$. To ascertain now the delivery volume of the air compressor, we take this rating, the first two figures of it as they stand and the other two figures by approximating, and locate it on the base line reading from the left hand corner. Taking 15 spaces and a little less than a half of the next space we note the vertical distance from this point up to curve *A*, and this we find to be 26, and a little more than half of the next space, say, 26⅝, or, decimally, 0.2662, and this being the ratio of the terminal to the initial volume, the actual terminal volume per minute will be $900 \times 0.2662 = 239.58$ cubic feet.

The volume thus ascertained is, of course, the volume actually delivered and at the moment of delivery, assuming that the compression was perfectly adiabatic throughout, or that the body of air, while being compressed, neither lost nor gained any heat by conduction, radiation or otherwise, and as a matter of fact this is nearly the actual state of affairs in ordinary dry compression. If, during compression, the air could be maintained at constant temperature the ratios of volumes would then be practically the same as the ratios of pressures, and the "curve" for this would be a straight diagonal from the lower left-hand to the upper right hand corner.

To ascertain now the ratio of temperatures as the result of our compression the operation is similar, except that in this case we use curve *F* instead of curve *A*. Taking our ratio of pressures 0.1544, with which we started, but this time reading from the right hand corner, we find the vertical reading to curve *F* to be 0.58, or so little above this that the excess is negligible. We note in the table that the reciprocal of 0.58 is 1.724, and this it will be convenient to use here. If the initial temperature of the air was 60 degrees Fahrenheit, then the absolute initial temperature would be $60 + 461 = 521$, and the terminal temperature would be $521 \times 1.724 = 898$ absolute, or $898 - 461 = 437$ degrees Fahrenheit.

If we take our ratio of volumes 0.2662, as previously ascertained and reading from the left hand corner note the vertical reading to curve *E*, the ratio of temperatures will be found to be the same as that obtained from curve *F*.

If we take any horizontal line of the chart, or any horizontal line arbitrarily placed upon the chart and note the points where curves *E* and *F* cross it, then the distance from curve *E* to the left-hand vertical boundary will be the ratio of volumes for that temperature ratio and the distance from curve *F* to the right hand will be the ratio of pressures, so that all particulars embodied in curves *A* and *C* are really obtainable from curves *E* and *F*.

or motor, only in one case the ratio as given would be the convenient multiplier in our computations and in the other case the reciprocal would apply, so that the reciprocal for every ratio is provided in the table as here given, for practical working purposes.

The table is not entirely new, the principal elements of it having been computed more than 30 years ago by Richard H. Buel and published with other valuable matter, in Appleton's "Cyclopedia of Applied Mechanics." The reciprocals of all the ratios have been added and the chart has been entirely plotted from the table, the smoothness of the curves in the plotting attesting the accuracy, or at least the consistency, of the figures.

The several curves of the chart are designated by the same letters as the columns of the table to which they correspond, adiabatic compression, or expansion, being assumed throughout. The several series of ratios, whether in the curves of the chart, or in the columns of the table are as follows:

A=Ratios of initial and terminal volumes of air for given ratios of absolute pressures.

B=Ratios of initial and terminal volumes of saturated steam for given ratios of absolute pressures.

C=Ratios of initial and terminal absolute pressures of air for given ratios of volumes.

D=Ratios of initial and terminal absolute pressures of saturated steam for given ratios of volumes.

E=Ratios of initial and terminal absolute temperatures of air for given ratios of volumes.

F=Ratios of initial and terminal absolute temperatures of air for given ratios of absolute pressures.

The formulas (from Rankine) by which the ratios in the several columns were computed are at the top of the next column, $\frac{1}{R}$ being the ratio in the first column of the table:

$$A \ldots\ldots \left(\frac{1}{R}\right)^{0.71}$$

$$B \ldots\ldots \left(\frac{1}{R}\right)^{\frac{16}{17}}$$

$$C \ldots\ldots \left(\frac{1}{R}\right)^{1.408}$$

$$D \ldots\ldots \left(\frac{1}{R}\right)^{\frac{17}{16}}$$

$$E \ldots\ldots \left(\frac{1}{R}\right)^{0.408}$$

$$F \ldots\ldots \left(\frac{1}{R}\right)^{0.29}$$

To anyone appreciating and capable of intelligently using the table, any explanation of methods of procedure would be superfluous. The table, although somewhat voluminous is essentially simple, as is also the chart which embodies it in every particular. As I would be glad to promote the use of the chart as a quick and handy means of obtaining closely approximate and reliable results, a single example of its manipulation is given under the chart on the preceding page.—*American Machinist.*

A SELF-STARTING GAS ENGINE

A four cycle internal combustion engine which is self starting without the aid of outside means is the invention of an engineer named Herman Dock. While compressed air is used, it is not its direct pressure upon the piston that effects the starting. The compressed air is forced through the carbureter to carry an explosive mixture into the manifold connecting the cylinders. Until actuated by the cam shaft the inlet valves remain seated under pressure due to the greater area of a balancing piston on the valve stem. After the start produced by exploding the compressed mixture the compressed air is cut off and the pressure in the manifold becomes again atmospheric. Thereupon the check valve opens and the engine operates in the ordinary way. A mechanical feature of the engine that is a departure is the connection of the piston and rod by a cup joint instead of the usual wrist pin. As a consequence the piston floats—that is, is free to rotate with respect to the axis of the rod, which has the effect of making the wear more uniform.

A suspension bridge with a clear span of 600 ft. has been constructed across the Culebra Cut on the Panama Canal, mainly to carry compressed air and water mains over the cut.

CAISSON DISEASE DISCUSSION

The valuable paper by Henry Japp, upon Caisson Disease and its Prevention, which in our September issue was reproduced in a condensed form from the Proceedings of the American Society of Civil Engineers, elicited interesting discussion upon its presentation before the Society. Taking the liberty of cutting where possible, the principal contributions to the discussion are here reproduced:

Dr. J. S. Haldane, F. R. S.—After very carefully reading Mr. Japp's paper, the writer considers it an extremely valuable contribution to a practical solution of the prevention of caisson disease. He clearly points out the difficulties involved in adopting without modification for all compressed-air work the plan of "stage decompression" worked out by Dr. Boycott, Lieutenant Damant, and the writer, which has been in successful use since 1907, for divers of the British Navy. A full account of the experimental evidence on which this plan is based will be found in the *Journal of Hygiene*, 1908, pp. 342-443. Most of the experiments were made at very high pressures, such as 75 lb., and they were carried out with a view to deep diving. Work in tunnels and caissons, however, is conducted at much lower pressures; practical experience is much more wide; and, thanks mainly to Mr. Moir, recompression is usually readily available. It becomes a question, therefore, whether the margin of safety which was allowed in decompression cannot be narrowed without appreciable danger. The new evidence which Mr. Japp has brought forward certainly seems to indicate that this is the case. He records the fact that in the construction of the East River Tunnels 330 "seasoned" men were employed for 36 days in two 3-hour shifts at a pressure of 40 lb., and were decompressed by a modified form of stage-decompression in 48 min., without a single serious case of caisson disease occurring. Thus there must have been about 24,000 individual decompressions without any mishap. Mr. Japp calculates that the maximum air-saturation left in any part of the bodies of these men at the end of decompression, corresponded to a pressure of 27 lb. In view of these results the author proposes to shorten stage-decompression in such a way that in place of the 19 lb. of residual saturation which the writer has proposed, 25 lb. should be left in the case of men who are "seasoned" to the work. This would greatly shorten stage-decompression, and render it a much more easily practicable process, although the pains in joints, etc., which are the most easily produced and the least serious symptoms of caisson disease, would not be prevented.

The reason for the proposed 19 lb. is that occasional serious cases seem to occur at working pressures down to 20 lb., and that a fatal case is recorded at 23 lb. On the other hand, there can be little doubt that for the great majority of men a pressure of 25 lb. would not cause appreciable danger.

Susceptible individuals can doubtless be excluded, to some extent, by a careful medical examination, with special regard to the state of the heart and blood vessels, and to any general debilitating cause, among which age must be included. Another very important factor is fatness. Dr. Boycott and Lieutenant Damant decompressed 70 guinea pigs at a dangerous rate after exposure to a pressure of 100 lb. Exactly half of the animals died of caisson disease, and the other half were killed. The percentage of fat was found to be much greater in those which had died of caisson disease. In consequence of these experiments, all British naval divers are now disqualified at the medical examinations from deep diving if they are inclined to fatness.

While a medical examination will probably exclude most of the more susceptible individuals, it still seems very doubtful whether all can be excluded in this way. With new men, therefore, it is desirable that preliminary trials should be made with short shifts. These men should be carefully watched after decompression, and promptly recompressed if they show any threatening symptom; and any man who has shown threatening symptoms should be rejected.

With these precautions, in addition to having a medical air-lock and keeping the men within reach of recompression for about an hour after they come out, the writer thinks that in all probability Mr. Japp's plan would prove successful.

The conditions vary so widely in different kinds of work in compressed air that it seems hardly desirable to lay down, by legislation or otherwise, any hard and fast general rules as to decompression. The writer, however, thinks that for any particular undertaking in compressed air, special rules, suitable to the particular circumstances, should be drawn up and strictly enforced.

Dr. Frederick L. Keays.—The three great factors in the causation of compressed-air illness are: The degree of pressure, the time under pressure, and the decompression period. The degree of pressure is, of course, the chief factor, and this is not a matter of choice, but depends on the depth to which the work must be carried. The only means of preventing illness, then, which are left to the engineer are the regulation of shifts and of decompression periods. In the past it has been thought that the longer one stays under pressure, the greater will be the dangers of compressed-air illness. This is true, up to a certain point, namely, that at which there is complete saturation of the blood and body fluids with the gases of the air.

The body fluids are practically saturated at any given pressure in about three hours. This belief is based on the results of the work in the Pennsylvania East River Tunnels. From a study of the records, it was found that men working for periods of less than 3 hours were less likely to have "bends," and much less likely to have a serious illness than those who worked for 3 hours or longer. Furthermore, it was found that in comparing the results of 6-hour shifts—which, since they were divided into two 3-hour periods with an interval of 3 hours at normal pressure, really meant 3 hours' exposure—with the results of 8-hour shifts, at almost equal pressures and with corresponding rates of decompression, there were fully as many cases of illness with the former shifts as with the latter, and certainly more serious and fatal cases. The real danger in compressed-air work comes with or after decompression. For this reason the practice, which has been almost universally followed, of dividing the working shift into two periods, is a bad one, for it doubles the number of decompressions. The results would be better in tunnel and caisson work, if continuous shifts of 4, 6, or 8 hours were arranged to suit the pressures; say, 4 hours for pressures of from 42 to 50 lb. +, 6 hours for pressures of from 32 to 42 lb. +, and 8 hours for pressures below 32 lb. +, and if the decompression periods were increased to reasonably safe lengths of time.

The question of the decompression period is a difficult one to settle. In the first place it must be admitted that certain men have individual susceptibility to the effects of compressed air. While one man may work even at a high pressure and decompress rapidly without any symptoms of illness, another, under even more favorable conditions of pressure, length of shift, and time of decompression, may succumb to sudden death from syncope and collapse, and the autopsy will show large quantities of free gas in the circulatory system. Among practical compressed-air workers there is a decided difference of opinion as to the necessary length of decompression periods, some even claiming that quick decompression is preferable. Nearly all men, however, who have dealt with the subject from the physiological and medical standpoint, have advocated fairly long times for decompression. The writer believes that lengthening the time of decompression is the most efficient means of reducing the number of cases of compressed-air illness, as well as the number of serious cases.

On account of the common occurrence of cases of delayed onset of symptoms, it is not believed that lengthening the decompression to periods claimed by Bert, von Schrötter, Hill, and Haldane, to be safe, would prevent all cases of illness, or even serious and fatal cases. A comparatively large number of men first begin to have symptoms of compressed-air illness several hours after decompression, in some cases after as many as 12 or 15 hours, and in a fairly large number, after 3 hours. In two fatal cases symptoms began to appear between 2 and 3 hours after decompression. Reasonably long decompression periods are, however, efficient in reducing the number of cases of illness, disability, and death.

Just what are reasonably safe lengths for decompression periods have never been determined. In the work on the Pennsylvania East River Tunnels after April, 1906, a rate of decompression of at least 1 min. for each 2-lb. pressure was required, and quite generally followed. This seemed to cause less illness and a reduction in the number of serious cases, as compared with previous months when there were no rules as to the rate of decompression. Even this rate of decompression, which was longer than has been required in any compressed-air work in the United

States, did not prevent serious and fatal cases. For this reason the writer thinks that even slower rates of decompression should be tried for pressures above 28 lb. +, below which this rate of 2 lb. per min. appears to be safe.

If it were possible, in accordance with Dr. Haldane's suggestion, to arrange a large decompression chamber in which a pressure equal to one-half the actual tunnel pressure could be maintained, where the men could pass a long decompression period in comfort, and use the time for bathing and dressing and, perhaps, for eating, it would probably prove a valuable means of preventing illness, and, at the same time, permit of working with comparative safety under higher pressures than could now be attempted.

Medical supervision and examinations are important and are instrumental in preventing serious results from the effects of compressed air. Men with organic disease are certainly less able to withstand the effects of compressed air than normal individuals. New men are certainly more susceptible to the effects of compressed air than old workmen. When high pressures are being used, a preliminary test of about 1½ hours under tunnel pressure for all new men, followed by a second medical examination, and short shifts of from 1½ to 2 hours for the first working period, are effectual means of guarding against serious results among new workmen.

Compressed-air work in tunnels and caissons, where pressures above 30 lb. + are used, will always remain a dangerous occupation in spite of all reasonable precautions, for one can hardly hope to prevent all cases of illness. Those cases due to small quantities of free gas are almost sure to happen, and a small proportion of them is likely to result in paralysis, which may cause permanent disability or death. Until the reason why certain men are susceptible to the effects of compressed air, can be learned, and such individuals can be recognized, cases of sudden death from large accumulations of free gas are almost certain to occur occasionally.

Dr. Albert J. Loomis.—After a pretty wide experience, extending back over twenty years or more, with pressures ranging from 15 to 42 lb., gauge pressure, the speaker cannot agree with the author of the paper, or his authorities, as to the cause of the disease under discussion. While admitting the "saturation theory" as laid down by Bert, von Schrötter, Haldane, and others, the speaker does not think that it is the cause of the so-called caisson disease, for the following reasons:

First.—As to the formation of bubbles of gas or air in the blood-vessels themselves: They have only been demonstrated in exceedingly high pressures—15 or 20 atmospheres—which, at the present times, are considered impracticable as working pressures. If these bubbles should occur in the blood-vessels of the men, working as they do and coming out as they do, there would never be any use for hospital locks, as the men would all die of suffocation before they could be gotten to them, owing to these minute bubbles becoming entrapped in the very small vessels or capillaries of the lungs, and thereby preventing the oxygenation of the blood, a condition which operating surgeons frequently meet, to their great regret.

Second.—If the symptoms were due to any change in the blood itself, there would be a general set attacking all parts of the body to a greater or lesser extent, which is the very thing that does not happen, but, on the contrary, they show themselves in a very few localities, and most of these localities are in the lower extremities, situations which any surgeon who is at all proficient in locating nervous lesions by their symptoms, would place without hesitation in the spinal cord, and in the lower portion of the cord.

On the other hand, there is practically but one set of symptoms, the so-called "staggers," which would lead physicians to look for a cause or lesion in the brain, a condition which is quite rare when compared with the great number of cases occurring in the lower extremities.

Should there be any change in the composition or condition of the blood, the brain would naturally be the first organ to show such change, as it is without doubt the most delicate organ of the whole anatomy.

In reference to the CO_2, the engineers of the North River Division of the Pennsylvania Tunnels have prepared a chart on which all the cases of compressed air sickness have been plotted, and this chart shows that, on that work, the greatest number of cases occurred at a time when the CO_2 was only 1 part in 1,000, with a pressure of from 20 to 25 lb., and, likewise, when the pressure was 28 lb and the CO_2 was 2 parts in 1,000, there were no cases of caisson disease.

While the speaker is not prepared to place much stress on the CO_2, other than as an indication of the general ventilation, he does think that weather changes play a very great part in the causation of the disease, as do also the habits of living of those engaged in the work.

When it comes to the examination of men, the medical officer should fit himself for the work by a close study of the conditions under which the men are to work, and his power of rejection should be absolute. The selection of the men should be the duty of one man who should be responsible for their welfare while they are at work under pressure.

In substantiation of these opinions, the speaker desires to state, that in the work of the Hudson Companies, in the construction of the Hudson and Manhattan Tunnels, about 38,000 men have been examined, since 1902, for pressures of from 15 to 42 lb., with three deaths, and in the construction of the North River tubes of the Pennsylvania Tunnels about 7,000 men have been examined for pressures of 15 to 38 lb., with no deaths.

William L. Saunders, M. Am. Soc. C. E.—This is a subject about which very little of practical value has been written, and the speaker is glad to note that Mr. Japp has gone into the matter in so much detail, both from theoretical and practical standpoints.

Caisson disease, or the "bends" as it is commonly called, does not differ from other diseases, in that doctors are very apt to disagree about it. Heretofore the subject has been treated in print mainly from a medical standpoint, various theories being advanced as to the cause of this disease, that is, whether it is due to mechanical or chemical action. The speaker remembers when the most plausible theory advanced for the cause of caisson disease was that the blood, which had been compressed and held in a state of tension, was suddenly released by decompression, creating a pain when coursing through the veins. This was illustrated by the statement that if a string is wrapped tightly around one finger and then suddenly unwound, the finger is temporarily in pain. The subject has been discussed so fully by Mr. Japp, however, and the theory of caisson disease has been so well established by the experiments to which he refers that it is now generally accepted that bubbles are the cause of the "bends."

Compressed air is the speaker's hobby, and in his early experience in seeking information about it he has soared, like the eagle mentioned by Mr. Japp, to a height of 3½ miles, where he has felt the earmarks of the "bends," and has descended to great depths in mines and in a diving apparatus under the sea, where similar sensations have been felt.

Personal experience in a matter of this kind always fits one to judge better the causes as well as the effects, and it may add something to the interest in this matter to recite an experience which the speaker had some fourteen years ago in the old Hudson tunnel, now called the McAdoo tunnel. This tunnel was started by Mr. D. C. Haskin a little before, or about the time of, the Centennial Exposition in Philadelphia, in 1876. Mr. Haskin conceived the idea of driving a tunnel under the Hudson River by maintaining a chamber of compressed air to hold up the face. He used no shield, and as the material through which he worked was more or less unstable, he met with considerable difficulty and some lives were lost. He sank his entire fortune in the enterprise, the work being taken up later by English capitalists, who contracted with Messrs. Pearson and Son to finish the tunnel. At that time E. W. Moir, M. Am. Soc. C. E., was in charge of the work, and the experience which he gained there has no doubt helped him to design and carry through the recent tunnel construction under the East River, which Mr. Japp has so ably referred to and with which he has been connected in so important a position. During the administration of the Pearsons, the late R. P. Rothwell, M. Am. Soc. C. E., at that time editor of the *Engineering and Mining Journal* and the speaker, were invited to examine the tunnel for the purpose of making a report thereon. About an hour was spent under some 35 lb. absolute pressure. Coming out of the locks rather rapidly, on reaching the washroom, the speaker was taken with a severe attack of the "bends," the effect being like that of a paralysis of the lungs. A horizontal tank, resembling a common horizontal boiler, was at hand, and the patient was transferred to a bench of straw, the door was closed, compressed air was turned on, and the relief was instantaneous. A pressure valve, provided for the purpose of admitting and discharging pressure from the tank, was used to enable the air to escape, but it was noticed that when the pressure fell only two or three pounds the "bends" returned, and it was only by the gradual reduction of the pressure, occupying about ½ hour, that the patient was able to open the door and walk out cured. The necessity for reducing the pressure gradually, as shown very decidedly by the return of the "bends," indicates the value of the theory of gradual decompression. It also bears out the idea that time must be given to permit the escape of the little bubbles which accumulate in the body.

An interesting incident was noted in connection with this experience. When the pressure in the tank was lowered, through the discharge of air, a fog formed instantaneously, and as soon as air was let in and the pressure increased, this fog was as promptly dissipated. The speaker experimented with this for some time—manufacturing and annihilating fog. The lowering of pressure, of course, resulted in cooling the air, and, *vice versa*, increasing the pressure heated the air. As the air was cooled, fog was produced immediately when the temperature reached the dew point, the capacity of air for moisture depending entirely on volume and temperature, that is, a certain fixed volume of compressed air, or free air, can hold only a certain quantity of moisture at a certain temperature. If the temperature is raised, it will hold more water; if the temperature is lowered, the moisture must be precipitated, first in fog, and later in the form of rain.

Walton I. Aims, M. Am. Soc. C. E.—The literature on caisson disease is quite extensive. The causes of the disease now seem to be well determined, but difficulty is found in conforming practically with the medical rules and regulations for its prevention.

The age of the compressed-air worker has an important bearing on his ability to withstand the effects of too rapid decompression, but youth generally lacks experience, and, in difficult work, some compromise has to be made in drawing the age limit for entering the compression chamber. Dissipation acts strongly in undermining a man's resistance to the effects of compressed air, especially among workers of mature years, and even some temporary indisposition may occasion an attack in one who has previously been pronounced physically fit by a medical examiner.

In nearly all compressed-air work there is difficulty in compelling the workmen to take a reasonable time in the air-lock while decompressing. Believing that this is due largely to the extremely uncomfortable conditions in the ordinary air-lock, a method for relieving the lock of the cold and fog when decompressing was used at the Battery-Brooklyn tunnel by introducing a constant flow of heated dry air while the lock was being exhausted. In addition to removing the cold and fog from the lock, this heated air also provided for ventilation while decompressing, a feature not found in the ordinary compressed-air lock. The comparative freedom from caisson disease at the Battery-Brooklyn tunnel, where practically no age limit was established, seemed to indicate the value of thus heating and ventilating the air-lock during the decompression period.

Dr. Seward Erdman.—The speaker wishes to acknowledge his appreciation of Mr. Japp's instructive contribution to the literature of caisson disease, and feels that the general adoption of the suggested "Step Decompression Method" will aid much in robbing compressed-air work of its gravest dangers.

The reduction, to terms and curves of mathematical precision, of the time and pressure elements, as shown on his charts, is most interesting; but it seems to the speaker that there will always be another factor to be reckoned with, one which cannot be reduced to mathematical terms, and yet which will continue to render uncertain the result of exposure to compressed air in each individual case. This indeterminate factor may be called the "personal equation," and seems to be dependent on the functional efficiency of the circulatory and respiratory apparatus.

In the experience of all who have seen much of compressed-air work, cases are not infrequent where men who are seasoned air workers will work daily, for long periods of time, at fixed conditions of pressure, length of shift, and decompression time, without suffering any ill effects, but who will come to work the next day, under exactly the same conditions, only to develop a severe or even a fatal attack of "bends."

The decompression time, indicated on Mr Japp's charts, can be controlled by valves from the air locks; but, for the individual, desaturation of the body tissues and the blood must take place through the lungs, therefore the lungs act as the "escape valve" for the individual. In explanation of such accidents as are above cited, it is likely that this "escape valve" is temporarily clogged. Desaturation of any given part of the body will be impeded by causes which slow the blood current in that area. Thus passive congestion of the lungs, or the presence of mucus in the air spaces (as from a cold) may act as clogs to the "escape valve," thus increasing the time necessary for desaturation; and, under such conditions, the body does not rid itself of the gases in the average time, and an attack of "bends" results.

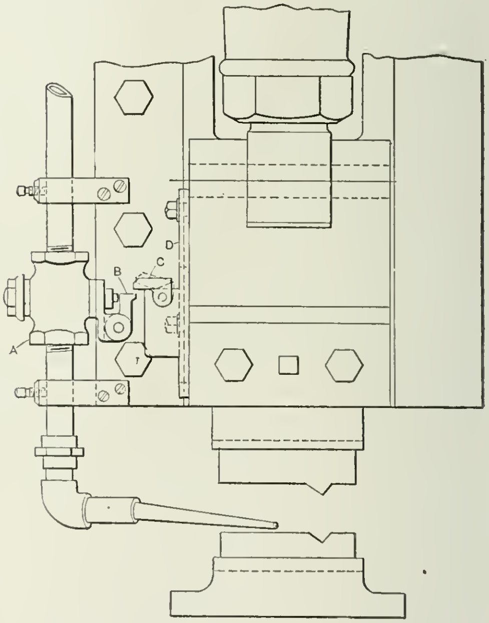
THE MECHANICAL ENGINEER'S SAFETY VALVE

The mechanical engineer is not very well recognized as a professional man in America, but he is coming to his own by and by. I got myself into a peck of trouble with my civil engineering friends by speaking out in meeting. I, of course, knew that the gentle art of killing people was several years ago the most prominent business of the day, and that military operations needed a military engineer, but when they got to doing peaceable things the man who operated things was called a civil engineer in counter distinction to his military brother, and civil engineers got into the business of building dams, waterworks, railroads, bridges and canals; but my own personal experience, I said, seemed to show that civil engineers figured up something, giving a lot of cubic feet of material, and figured up how much something was going to cost, then they hired a good Irish contractor who undertook the work and carried it along, and it was carried along by the work turned out in the shape of steam shovels, rock drills, boilers and engines, which were entirely the product of mechanical engineers, and when they got through the civil engineer's figures were anywhere from 100 to 600 per cent. from being correct. Of course, a civil engineer cannot see into the ground, and the weather cannot always be counted on, but it seemed to me that instead of being the "dog" a civil engineer was the tail of the profession of engineering.

I know some first-class civil engineers who do not figure as above, but they have either been practical contractors or practical mechanical engineers before they took up civil work. —*W. D. Forbes in American Machinist.*

A DIVER CLEARS THE PUMP

The Draper mine, at Soulslyville, Cal., has been idle for five years and it was lately decided to unwater it and resume operations. Two 10 in. pumps were in the shaft, but while the mine had been idle a cave-in had occurred, so that it was impossible to start them. Air was used to raise the water above the 350 ft. station, and when the pump there was reached it was put into operation. The air was then applied to raise the water still below this pump to reach the other at the 600 ft. station, but when the water was down to within 75 ft. of this the air lift failed to work. A diver was then employed who found the suction of the pump almost entirely covered with mud and loose rock. After a day's work he had so cleared things away that the water was then lowered rapidly and the bottom of the shaft was soon dry again.



COMPRESSED AIR BLOWS THE WORK AWAY

The cut shows an arrangement for blowing work from a forming die in a punch press, as used upon about forty presses in a large plant. A plain forming die is shown in position under the plunger and at the left of the plunger is the valve A with its attachments. This is a Lunkenheimer whistle valve held by the pipes attached to each end, which in turn are held by the clamps attached to the frame. Below the valve there is a union and other connections with a bent tube which may be turned as required to give the best effect. The regular whistle valve tube has been removed and in its place the trigger B is mounted. This trigger remains in the position shown when not in action. On the descent of the plunger the pawl C swings back to pass the trigger but on the upstroke it pushes the trigger and causes a puff of air which removes the formed piece on the die. Other uses of the device will suggest themselves.—*Machinery.*

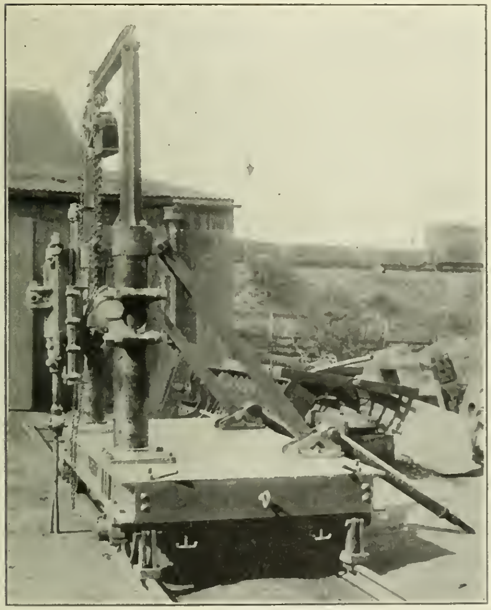


FIG. 1. VERTICAL DRILLING.

A SPECIAL TRUCK FOR HEAVY DRILLING

The little half tones herewith tell very satisfactorily the story of a special drill truck built by the Ingersoll Rand Company for a foreign customer. The truck provides not only for the carrying of heavy drills, 3½ to 5 inch, but embodies in itself the securest and firmest possible mounting for the drill at work, with facility of handling and a very complete range of adjustment. The chain hoist locates the crossbar so that it can be clamped at any height, and the drill saddle may be slid anywhere along the bar and set at any angle in the vertical plane or laterally as required. The legs at the back are tightened by the jackscrews to steady the frame when the drill is at work and the car is firmly clamped to the track at each corner, the clamp being tightened by driving down the clamping collar. Fig. 3 shows how

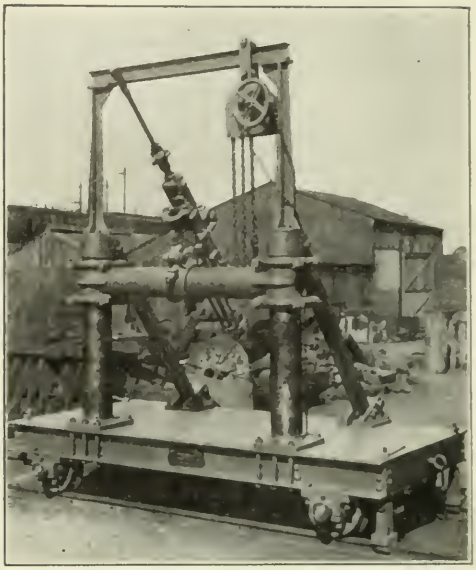


FIG. 2. ANGULAR DRILLING.

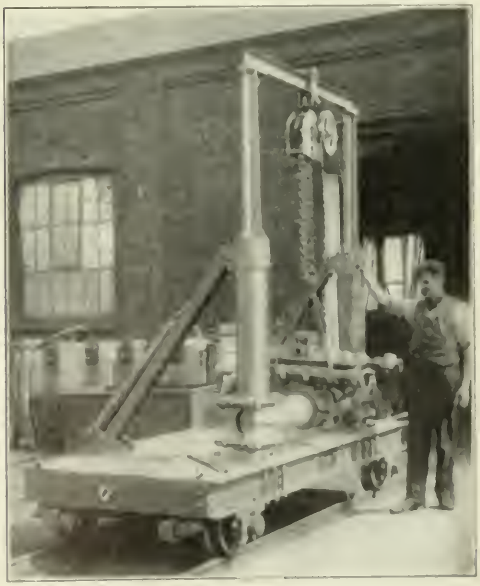


FIG. 3. READY TO MOVE.

the track clamps and the back legs swing up out of the way. The drill shown on the bar can also be swung around so that nothing will overhang when the car is moved along the track. It is understood that with this drill mounting holes are to be put down to depths exceeding 50 feet. The solidity and general adaptability of the rig speak for themselves.

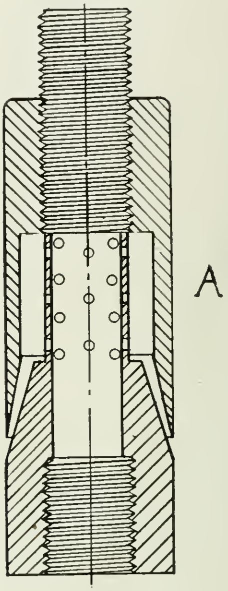
AIR LIFT PRACTICE

The following is from a "talk" by Mr. Sam Skelly before San Francisco No. 1, N. A. S. E., as reported by the *Journal of Electricity, Power and Gas.*

The utility of the air lift for handling water is most evident where a number of wells are to be operated at some distance from each other, or from a central plant, and where large quantities of water are to be brought to the surface or water impregnated with mud or sand is to be pumped; these conditions making steam or power driven pumping machinery expensive to instal, uneconomical in operation and costly as to maintenance. In such conditions the air compressor can be cheaply substituted for numerous pumping heads, and the air piped to the various wells at small expense. The air lift, if properly installed, will work satisfactorily with practically no attention, requires no repairs and will handle dirty water that would ruin a pump, without trouble or damage to itself.

The principle of operation of the air lift was simply explained as being the creation of an effective head between two columns of water by lessening the density of the discharge column with the introduction of air intimately mixed in the ascending column. In order that this head shall be practically effective there must be a degree of submergence proportional to the proposed lift. This was stated to be about 60 per cent. for a reasonable efficiency. Under such conditions as high as 75 per cent. efficiency has been attained. When the quantity of water raised is greater than the supply, causing a reduction of level and less submergence, the efficiency decreases rapidly, approximately as the cube of the distance of drop of water level. Greater submergence than 60 per cent., however, gives no additional advantage, and where the depth of water exceeds this the apparatus should be submerged only the necessary depth.

The sketch shows an air improved jet designed by Mr. Skelly, wherein the air is introduced with the lift pipe in a film which gives a constant flow of water. The thickness of the film can be varied by screwing the sleeve A up or down.



An empirical rule for determining the size of discharge pipe to use for ordinary purposes is as follows: Provide one square inch area of discharge pipe for each four cubic feet of free air per minute capacity of compressor. This rule gives excellent results for the usual conditions found. An air pressure of four atmospheres is found to give best results under the same conditions. (The pressure must, of course, vary according to the submergence. Ed. C. A. M.) The substitution of several small pipes of equal aggregate area instead of one large pipe for the discharge gives better efficiency on account of the fact that the tendency of the air to create a hollow column inside the large pipe is thus overcome. This arrangement is also easier to install on account of the smaller pipe used.

In cases where the discharge is to be in elevated tanks at some distance from the well, it is necessary to carry the discharge directly to the necessary height and then terminate with a horizontal run, or where this is not feasible a stand pipe may be provided to receive the water from the well and otherwise piped to the storage tank.

The apparatus will not work satisfactorily with a horizontal run in the discharge below the level to be reached on account of the fact that the air being lighter than the water will separate from the column and leave it dense at the bottom of the pipe.

Under certain conditions a dual system may be installed, using the air lift to bring the water near the surface, and from that point taking it with a suction and lift pump to the tank. The cup at the bottom of the pump suction collects the water from the air lift column, the air passing on upward, providing a continuous supply to pump. This system is applicable to deep wells where the conditions will not permit the use of the air lift alone and where a deep well pump is not advisable.

There are many cases where the use of an air lift instead of a pump is attended with incidental advantages, as when the water is to be used for cooling or condensing purposes, the refrigerant effect of the expanding air being sufficient to lower the temperature of the entire body of water, in some cases as much as twenty degrees.

BUSINESS OPENINGS FOR ENGINEERS

A recent leader in *Engineering-Contracting* speaks of the business opportunities inviting the engineer in the production of crushed stone for concrete contracting and goes into details as to the possibilities of reducing costs. A few of the suggestions follow:

We do not know of a single quarry where the drillers are paid on "the hole contract system," that is, on the basis of a piece rate per lineal foot of hole drilled. It has been demonstrated again and again that by paying rock drillers according to the number of feet of hole drilled—whether by a straight piece rate, or by a differential piece rate, or by a bonus system—the output is increased 50 to 100 per cent. This needs no argument, but, unfortunately for both drillers and quarry owners, there exists such a mental inertia among business men that changes in methods of payment and management are about as slow in developing as are changes in the styles of building bird's nests. This very adherence to old methods, however, constitutes the secret of the real opportunity that lies before the engineer who goes into business, for he enters it free from the tyranny of precedent and with a mind keenly critical of the old methods and eager to try the new.

In all the quarries that the writer has visited he has not once seen a water jet in use for the purpose of removing the sludge as rapidly as formed and thus accelerating the speed of drilling. Here, again, is a method about which there can be no dispute, for it has been tried in all kinds of rock and rarely without an astonishing increase in the number of lineal feet of hole drilled by each machine. As far back as the great Hell Gate blast in New York harbor, the water jet was found to cause an increase of 25 per cent. in the drill output when working in the gneiss and mica schist that was encountered. Yet there are hundreds of self-called "experts" in excavation who believe that a water jet is of no use except in soft shales and the like. There are water jets and water jets. If the current of water that flows from a drill hole is weak, it will raise only the most minute fragments of sludge; but if it is a trifle stronger, rock chips of considerable size are elevated and removed, thus freeing the drill bit of the work of pulverizing the chips.

In all the quarries that we have visited we have not seen one drill sharpening machine in use, although such machines are commonly found as a part of the plant used in mining. This, in itself, is not a matter of great economic moment, perhaps, but it merely shows the general ignorance or apathy existing among most of the men who run quarries.

Chamber blasting is almost unheard of among quarrymen, although it is the most economic known method of loosening large quantities of rock, both as regards the cost of drilling and of explosives. It is true that, after making a chamber blast, the largest chunks must be drilled and blasted. However, when a chunk of rock is free on all four sides, it requires comparatively little powder and a correspondingly small amount of drilling to break it up. In the breaking up of these chunks, both the ordinary rock drill and the pneumatic plug drill (or hammer drill) are used to advantage, the former for the biggest chunks and the latter for the smaller pieces.

Perhaps the commonest economic blunder seen in quarry work is the use of rock crushers of small size. A small crusher necessitates either the close spacing of drill holes, or the sledging of pieces of blasted rock, or both. The average quarry owner seems to reason that because his daily output will not be large he does not need a crusher of a size larger than will just deliver this small output. The fallacy in this sort of reasoning is seldom discovered, for the close spacing of drill holes, and even the sledging of the rock, come to be regarded as necessary.

In so simple a process as the feeding of a rock crusher there is a woful lack of know how. Feeding from bins or chutes enables one man to do more work than three or four men can do when lifting stone from a floor into a crusher.

To the engineer who contemplates going into the business of producing crushed stone, we would suggest the advisability of first studying the literature on rock excavation—including all catalogs—with care. This should be followed by a trip through the country, visiting not only the ordinary crushing plants that are run by manufacturers of crushed stone for concrete, ballast and macadam, but also the large plants operated at Portland cement factories, and particularly the milling plants at some of the metal mines. Often a method in use on a large scale can be modified and adapted for use on a small scale, so that the mere fact that a plant is very large and elaborate should not militate against a study of it by a man who contemplates installing a small and simple plant.

SURGERY AND PURE AIR

What may come to be known in the history of surgery as the Bush Case is likely to have considerable weight among sufferers from appendicitis, according to the memoranda of Drs. McBurney and McArthur, the surgeons in charge of the operation upon C. Adolph Bush, a boy upon whom the operation for appendicitis was performed aboard the Mauretania on a recent trip eastward. The ship was three days out from New York when the boy's condition became serious, and the expert surgeons, who very fortunately were on board, decided to operate at once. The captain offered to shut down the engines during the operation, but this was declared unnecessary by the doctors, since the sea was smooth and the weather clear. So the operation was performed while the ship was making twenty-three knots an hour.

The point—one might say the McBurney point—of great interest both to the patient and the whole profession is that the boy recovered consciousness much more quickly than usually occurs in hospital cases ashore, and immediately began to mend. His progress was rapid and by the time the ship docked at Liverpool the physicians agreed that he might safely be removed to the Liverpool hospital, where he was considered out of danger and expects to continue his journey to Scotland in a very few days. The telegram from London describing the occurrence informs us that Drs. McBurney and McArthur attribute the quick recovery not only to the physical buoyancy of the young patient, but in a great degree to the exhilarating effect of the sea air and the absence, at sea, of deleterious germs.

This being the case, marine operations for appendicitis will naturally become almost imperative, for it is the merest common sense to give the patient every chance. The number of sufferers from appendicitis who are not financially able to command their own steam yachts for the operation, or at least to go to sea on a big steamship, is so small as to be neglible. Therefore it will soon become bad surgical form to perform this operation ashore, and in a short time an operating room will be a more necessary part of a ship's equipment than, say, a "Social Hall," or a theatre.

The upholders of mountain climbing as a sport may contend that the air at the summit of almost any peak is as wholly free from germs as the air in midocean; but the seagoing surgeons will doubtless retort that the patient's heart would be more likely to give out under chloroform at a height of from three to five miles above the sea level than on the sea. So the marine operation is likely to be preferred *Evening Sun*, N. Y.

[It can hardly be presumed that mountain air is as pure as that in mid-ocean; besides that and the levity of the air, there would be complications as to temperature, not to speak of the difficulty of safe and comfortable transportation.]

At a meeting of representative electrical engineers of South Africa, held at the Grand National Hotel, Johannesburg, South Africa, on July 12 last, a new electrical institution was founded with the name and title of the South African Institute of Electrical Engineers.

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THE INTAKE PRESSURE IN AIR COMPRESSOR CYLINDERS

We have before us a copy of a paper by Mr. A. C. Whittome, read before the Transvaal Institute of Mechanical Engineers and printed in the Journal of the Institute. The paper deals with the general problem of "Compressed Air Production and Use," and has the special merit of calling attention to more of the factors of the problem than are usually recognized, and of stating the entire case with unusual candor and clearness.

We mention the paper here, however, rather to take exception to one of its assumptions as not warranted and as not sustained by the explanation which the writer offers. Speaking of the typical air cylinder indicator card the paper says:

"It is hardly necessary to state that the inlet lines must be below the atmospheric line (for low pressure cylinders, or intercooler line for high pressure), even if mechanically opened inlet valves are employed, the friction in pipes, passages and ports, and the changes of velocity, etc., ensuring some slight drop. If spring loaded inlet valves are employed this drop below atmospheric pressure will be increased, and the proportion of work performed in drawing air into the cylinder will rise also. And yet how seldom it is that a card is seen on which the pressure at the end of the inlet stroke does not practically coincide with the atmospheric line; in fact, it is nothing unusual to see it shown on the top edge of the atmospheric line. It is frequently claimed that this is due to the admirable system of inlet valves employed on the compressor, and their excellent condition, the fact being ignored that if it needs an excess of pressure on the outside of the cylinder to overcome pipe friction and the resistance of valves, this excess of pressure must also be, to some degree, apparent at the end of the stroke, otherwise air will not flow into the cylinder. The real reason that the pressure rises to atmospheric (and sometimes above it) at the end of the inlet stroke, is that the air has become heated by passing over hot surfaces and by contact with cylinder walls and head and piston, and the pressure has thereby been increased."

We are compelled to characterize the explanation as absurd. It is undoubtedly true that there is no compressor built, and apparently no possibility of designing one, in which the air at normal atmospheric temperature must not pass over or come in contact with some metallic surfaces at a temperature higher than this before it is actually within the compressing cylinder and ready for the compression to begin, so that we may say that, by conduction or radiation, the temperature of the cylinderful of air at the instant when compression begins must always be somewhat above that of the outside air. Whatever may be this use of temperature, however, it can in no way affect its pressure until the inlet valve is closed. During the suction or intake stroke the only thing which causes the air to flow into the cylinder is the pressure of the atmosphere behind it, or the excess of this pressure above that within the cylinder at the time. Whatever heating of the air occurs while it is rushing into the cylinder can only slightly augment its volume and not at all its pressure, and the increase of volume only cannot account for the height of the intake line at the moment when intake ceases and compression begins.

There seems to be an unaccountable hesitation about accepting what is apparently a very satisfactory and complete explanation of the phenomenon. Air has weight and inertia, and if we have it in a column which is alternately moved forward at a considerable velocity and then brought to rest, the alternations occurring quite rapidly, there must of course be an increase of the difference between the pressure in advance of the column and the pressure behind it which will cause the inrush of the air, and then to suddenly stop the advance of the column this pressure difference must be reversed. As the pressure behind the column is constant, being that of the atmosphere, the required reversal of the pressure difference can only be produced by an increase of pressure in front of the column, which is just what the indicator card shows in the cases under consideration.

A little look at actual, practical conditions will enable us better to realize what occurs to the intake air when the compressor is in full operation. We have to assume the existence of the column or elongated mass of air first of all, the sectional area of it being such that a high velocity of flow occurs. Where the inlet valves are in the cylinder head and not encased, so that the air is drawn in from that immediately surrounding the cylinder the inertia of the air of course counts for nothing for increasing the final intake pressure, but when the intake air is piped to the compressor in a pipe of suitable size to bring the air from outdoors, or from where it is coolest and cleanest, then we have the conditions looked for. With the piston inlet the column of intake air is a necessary condition, and compressors of this type quite generally show the cylinder full, or, as we might say, a little more than full of air at atmospheric pressure at the beginning of the compression stroke. The same phenomenon would be shown by other compressors giving the same conditions —a pipe of dimensions just adapted to the volume flowing through it, a full opening into the cylinder and a quick closing of the valve at the precise moment before compression begins.

ACCURATE SURVEY WORK

The meeting of the headings of the Gunnison tunnel affords an opportunity of checking up the survey work for laying out the tunnel. The tunnel is six miles long and survey had to be conducted through a very rough country in order to locate the two ends. Naturally, the survey lines were very much longer than the tunnel; hence, an exceedingly small error in the survey would have resulted in very serious error when the headings met. An error of one minute of an arc in a line six miles long would throw the alignment in error by at least nine feet. Yet, when the headings of the Gunnison tunnel came together it was found that the error in alignment was less than one-half an inch, in grade less than four inches and in length about ten inches. The figures given out by the Reclamation Service are as follows:

Error in alignment	0.04 ft.
Error in level................	0.32 ft.
Error in length..............	0.86 ft.

It may be of interest to compare this work with that done in laying out some other famous tunnels. In 1875 the Musconetcong tunnel on the Lehigh Valley road was found to be in error when the headings came together as follows:

Error in alignment	0.04 ft.
Error in level	0.015 ft.
Error in length	0.52 ft.

The length of this tunnel is about one mile, and shows exceedingly good work for commercial purposes.

The Simplon tunnel in Switzerland is beyond question the greatest tunnel project ever completed, and the survey problems presented were such as to tax the surveyors' skill absolutely to the limit. The portals of the tunnel are 19 kilometers apart, or about 13 miles Each entrance of the tunnel is made on a curve and there were several changes of grade in the tunnel. Combined with this, the triangulation lines had to be carried over some of the roughest country in the world. Yet, in spite of all these difficulties, when the tunnel was completed the survey errors were found to be as follows:

Errors in alignment......	0.202 meter
Errors in level	0.087 meter
Errors in length	0.79 meter

While these errors appear to be much greater than in the other two cases cited, yet, when one considers the tremendous difficulties in surveying in the Swiss Alps, the work of surveying for the Simplon tunnel must set a standard of accuracy to compare all other similar work with.

Some remarkable surveying work has been done also in mining. A number of years ago it was desired to rapidly sink a shaft in the Freiburg district in Germany. The shaft was worked from about a half a dozen different levels by means of raises and winzes. In order to fix the points for the miners to start work from, several miles of survey lines had to be run. Yet, when the shaft was completed, the error was so minute as not to be detected by most careful measurement.

Of course, it is not proper to compare commercial survey work with the goedetic work done under government auspices, yet an example of how accurately triangulation work can be done is given by the reciprocal measurement of the two main base lines from which the survey for the British Islands was started. These two base lines, which are several miles in length, are situated one in the north of Ireland and the other in the south of England. The Lough Foyle base line in the north of Ireland can be seen across the ocean from the south of Scotland. Taking the Lough Foyle base, a series of triangles were carried to the ends of the Salisbury Plain, or the south of England base line. On comparing the calculated length of the Salisbury Plain base line from the length of the Lough Foyle base with the actually measured length of the former base there was a difference of five inches. The Salisbury Plain base line is about five miles long, and thus there was an error, or rather a difference by triangulation and measurement of about one inch to the mile.

Now comparing the commercial work of laying out the Gunnison tunnel with frequently admired British Survey Service, it will be found that the error in length of the Gunnison tunnel, as shown by the difference between the triangulation and the measured length of the Gunnison tunnel, is about one and two-thirds inches to the miles, as against one inch to the mile as recorded in the previous paragraph.—*Mining Science.*

A TUNNEL USED FOR COMPRESSED AIR STORAGE

The following interesting account of the successful use of a discarded tunnel for the purpose of storing a considerable volume of compressed air is contributed to a recent issue of *Power and the Engineer* by Mr. C. Sangster, Rossland, B. C.

In any compressed-air plant a large receiver capacity that can store the air when the consumption is light and restore it when consumption is correspondingly heavy is very desirable. This is especially true of those plants where the compressor is driven by an electric motor. The conditions are then a compressor having constant speed and, in mining work, a constantly changing load

Compressors of modern design for electric drive are equipped with unloading devices which overcome, to a certain extent, the loss of power through the blowing off at the safety valve when a hoist or a number of drills are stopped for a few minutes But with an unloader thus cutting out the compressor every few minutes the daily capacity of the plant is very much less than if it were allowed to compress air constantly, and if that air could be stored and given back when all the drills and hoists happened to be at work at the same moment, calling for more air than the compressor could deliver, a great advantage would be gained

The storage capacity of the ordinary mining installation is very small Suppose a ten-drill plant has a storage equal to 5000 feet of 6-inch pipe and a receiver 48 inches by 15 feet These combined would hold 1188 cubic feet of compressed air, which at eight atmospheres would be equal to 9504 cubic feet of free air

If the compressor were stopped, only about one-third of this air could be used, as when about that amount had been drawn off the pressure would be too low to do effective work. Ten 3 1-4 inch drills at a 3000-foot altitude would pull down the pressure in this pipe line and receiving tank from 96 to 60 pounds in about four minutes.

At one of the mines in this district they have two electrically driven compressors with a combined capacity of 7500 cubic feet of free air per minute. These machines are equipped with automatic unloading devices which operate whenever the air rises to 100 pounds per square inch.

The idea of sealing up an unused crosscut in the mine and making of it a large underground air receiver was successfully carried out. The crosscut was roughly 9 feet high, 6 feet wide and 400 feet long and was driven through solid rock which showed no cracks nor seams. The bulkhead was built of concrete, 10 feet thick and carefully pointed on the inner side with strong cement. A 6-inch pipe connection and a manhole were built into the bulkhead; the manhole being sealed the same as a manhole in a boiler. When tested, it was found that this natural receiver lost only 10 pounds in 18 hours, one or two very small leaks around the bulkhead no doubt accounting for this loss.

The capacity of this crosscut is not less than 22,000 cubic feet, or is equal to 117 ordinary air receivers 48 inches by 15 feet. In free air compressed to eight atmospheres, it will hold 176,000 cubic feet, or the entire output of the compressors for 23 minutes. Allowing that one-third of this air is available at a working pressure, as cited, ten drills could be operated for 50 or 60 minutes after the compressor was stopped.

The advantage of such a large storage is very noticeable in the engine room. It tends to balance the rapid fluctuations in the load, the compressor and rope drive run more steadily and the unloaders cut out less often. The motors are not subjected to the strains of the load being constantly thrown off and on.

In the mine, a hoisting engine or a group of drills may be thrown on or off without seriously affecting the air pressure. In short, it stores and restores the air, piling up a reserve when a machine is stopped and giving it back when a sudden call is made.

This idea is not new, but the writer does not know of any other place where it has been successful, the difficulty usually encountered being the leakage of air through seams in the rock.

ATMOSPHERIC HUMIDITY THE SAFETY FACTOR IN COAL MINES

The following is from a paper by Peter Hanraty, Chief Mine Inspector of Oklahoma, before the Mine Inspectors Institute of the United States, Scranton June, 1909.

In studying and discussing the atmospheric conditions in the mines with shot firers and other parties, I maintained that if we could create the same temperature and moisture in winter as we had in summer, explosions would be almost unknown. In the winter of 1886, it was almost impossible to get shot firers. Many nights I had to fire the shots alone. It was on one of those nights that the idea struck me to use the exhaust of the pump, and the more I studied and experimented, the more convinced I became that steam was the solution of the problem. We not only used the exhaust from the pumps, but we laid pipe and allowed steam to escape into the intake airway. The steam as it escaped warmed the air, making the mine's condition practically the same in winter as in summer. We had no windy shots or explosions when we used the steam, but the moisture produced by the steam caused a slacking or disintegration of the roof, and, the slope and entries not being timbered, large falls were frequent, which entailed quite an expense, and orders were issued to discontinue the use of steam, which was done. In a very short time windy shots and disastrous explosions again commenced to become numerous. The following winter I quit the dangerous occupation of firing shots, and since that time numerous shot firers have been killed by explosions, and the number will continue to increase unless steam is used to heat the intake air, for explosions never happen from shots that have been fired after the air has traveled a long distance from the intake, and where the air has become the same temperature as the mine itself, but always happen nearest the intake, where the air is the purest and coldest. Nothing has occurred to change my views in the last 24 years; but continuous observation and investigation of explosions since that time has proven beyond the question of a doubt, that to overcome the dangers due to a cold-air current entering a mine and having its capacity to absorb moisture raised by the natural heat of the mine, it is necessary to heat the intake air and saturate the same at a point near the foot of the shaft, so that the air will pass into the workings at a normal temperature and practically saturated. I feel sure that if the atmosphere of the mine is always in the same condition, not allowing any change in the atmospheric conditions, due to sudden changes of temperature on the outside, such as the difference between summer and winter, if the ventilation is not in any way stopped, and if we keep the absolute amount of water vapor in the air-current always the same, then coal dust will not and cannot explode.

The custom of slowing the fan or in any manner reducing the circulation at, or just previous to, the firing of the shots, should be prohibited. The idea that mines are getting too much air is simply an endeavor to justify those who have too little. I believe that 50 per cent. of the shot firers that are killed in this state from windy shots, die from the effects of afterdamp, due to the insufficiency of air caused by the slowing or shutting down of the fan. A large volume of air should be maintained at all times and the temperature of the mines kept the same.

NOTES

The production of mineral wool in the United States in 1908 was 9197 short tons, valued at $77,228.

A pumping engine which was installed in 1815 is still in service at the Dolcouth tin mine in Cornwall.

According to the census of 1905, 44 per cent. of all the water power used in the United States is employed in the production of pulp wood and print paper.

Hot, moist air is oppressive because being saturated with moisture, or nearly so, evaporation of perspiration, which cools the body, takes place only slowly.

A borehole 7,370 feet deep is being drilled near Rybnik, in South Western Germany. By December, 1908, it had reached a depth of 7,070 feet, with a diameter of 2 inches.

A business communication in Arabic which came to a Manchester firm, when translated by a Syrian interpreter, was made to ask the price of "two water sheep," when really two hydraulic rams were wanted.

Mr. Frank H. Hill, long identified with the sales and engineering department of the New York office of the Sprague Electric Company, assumed the duties of Manager of the Branch Office in Atlanta, Ga., on Sept. 1st, in place of Mr. F. V. L. Smith, resigned.

At Radley, Ind., a considerable length of 10 inch gas pipe belonging to the Indiana Natural Gas and Oil Company, and buried three or four feet in the ground, exploded recently under a test pressure of 70 pounds. The ground was torn up and the pipe was hurled up in the air, but no one was hurt.

When firing a broadside of eight 12-in. guns, the Dreadnought of the British Navy, which is a vessel of 18,500 tons, slid sidewise several yards and listed heavily. Each of these guns is 53 ft. long and fires a shell weighing 850 lb. at a muzzle velocity of 2000 miles an hour, using a charge of 265 lb. of cordite.

At a quarry in Connecticut recently the men were busily drilling the rock when the drill steel broke and a large piece struck a large glass bottle of gunpowder while another piece struck the rock, producing a spark which fired the powder, and three men were severely burned and cut.

Mr. Quistgaard, a Swedish engineer, has published a plan for connecting Copenhagen and Malo by an electric railway through a tunnel under the Oeresund. The present line between Copenhagen and Malo is 22.35 miles while by the proposed tunnel route the distance would be 9.9 miles.

A mercury telescope has been experimented with by Prof R. W. Wood, of Baltimore The reflector is a twenty inch basin of mercury which when rotated becomes a concave mirror of focus varying with the speed. It is now proposed to make one ten or twenty feet in diameter for some southern station where it can be used for photographing details of the stars as they pass directly overhead.

According to a report to the Finance Commission, the cost of bricklaying by the Sewer Department of Boston, using day labor, ranged from $9.04 to $18.34 per thousand. The number of bricks laid per hour per man varied from 13 to 242. On the small sewers, built under contract in connection with the Metropolitan work, the cost ranged from $2.77 to $4.23, and the number laid from 165 to 384. The high cost for the city work was attributed to lack of sufficient work to keep the masons busy.

An altitude of 38,714 feet is reported to have been reached by Lieut. Mina, of the Italian army and Mr. Mario Piacenzo, on Aug. 10, with the balloon "Albatross." The balloon was a spherical bag of 2,000 cubic meters (70,000 cubic feet) capacity, but only 1,200 cubic meters of gas was carried at the start. A supply of oxygen was carried for breathing. A temperature of —24 degrees F. was recorded. The previous record for altitude was 37,000 ft., and was made by Messrs. Coxwell and Glaisher in 1862 in England.

The Chicago public laboratories recently made tests to determine the amount of soot and dust deposited from the air in that city. The acreage deposit, as estimated from samples collected at eight different points of different heights during a period of four weeks was, approximately, at the rate of 8.5 tons per acre, per year. On the Board of Trade building, 110 ft. above the street level, the estimated annual deposit was 10.5 tons. On the county building, 160 ft. above street level, the amount was 7.8 tons, and on the Reaper block, 12 ft. above street level, 12.6 tons.

The loftiest chimney in the world was recently put into service at the large smelting works at Great Falls, Mont., where it will serve to carry off the gases from the greater part of the large plant. The chimney, which is built of brick, is 506 feet in height above the ground. It is 50 feet in diameter at the top, and increases gradually in diameter to the base. The flue includes a dust chamber in which vertically-hung wires serve to take out the dust from the smoke. The dust is removed from the wires by shaking mechanism and falls in hoppers in the floor, from which it is loaded into cars in a pit below.

Deep mining in Victoria makes systematic ventilation imperative, if only to secure a tolerable working temperature. In order to carry on economical mining it is necessary to have as large a volume of air circulating through the workings as possible. For instance, at 4,254 ft. the rock temperature, 113.5 degrees, and the water, at 114 degrees F., requires a volume of natural air of not less than 10,000 cu. ft. per min. to maintain a temperature of 72 to 75 degrees. The temperatures vary from summer to winter. In driving dead ends a system of overhead bratticing has been introduced to keep a current of air circulating to the face. A volume of 1,250 cu. ft. is required in one mine to maintain a temperature of 86 degrees. This system is the best yet developed for deep ground. Blowers have been tried, with poor results, the ground being so hot the pipes acted as conductors and made the air too hot in a distance of 400 ft. They have been found to heat the air 10 degrees.

LATEST U. S. PATENTS

Full specifications and drawings of any patent moy be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

AUGUST 3.

929,655. THERMOSTATIC REGULATING DEVICE. Willis H. Carrier and Edward W. Comfort, Buffalo, N. Y.

929,740. EXPRESSION DEVICE FOR PNEUMATIC PIANO-PLAYING MECHANISMS. Joseph Wieser, St. Johnsville, N. Y.

929,746. CLEANING DEVICE. Patrick A. Bayless and Arthur C. Hein, Oklahoma, Okla.

929,764. MILKING-MACHINE. Joseph H. Hoover, Waterloo, Iowa.

929.799. VACUUM-PUMP. James L. Sparks and Edward R. Eddins, St. Louis, Mo.

929.832. SUBAQUEOUS ROCK-BREAKER. Barton H. Coffey, Boston, Mass.

929,909. AUTOMATIC CUT-OFF FOR PNEUMATIC-DESPATCH-TUBE SYSTEMS. Franklin H. Wolever, Chicago, Ill.

930,025. VACUUM SEALING APPARATUS. George A. Beardsley, East Orange, N. J., and Daniel Wardell, New York, N. Y.

930,087. ATOMIZER FOR PAINT OR THE LIKE. Reinhold Reich, Berlin, Germany.

930,120. AUTOMATIC AIR-GOVERNOR. Lewter W. Baker, Wilmington, N. C.

930,122. APPARATUS FOR EXTINGUISHING FIRES. Joseph O. Bannin, New York, N. Y.

930.125. PORTABLE VACUUM-CLEANER. Charles F. Barrett, Bridgeport, Conn.

930,127. PNEUMATIC FEEDER. Edwin M. Bassler, Chicago, Ill.

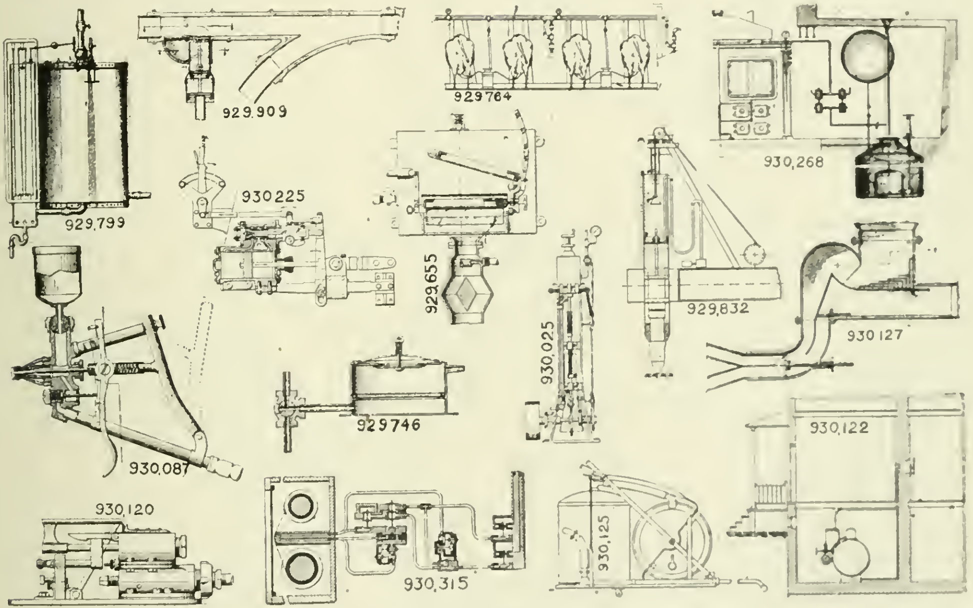
930,225. CONTROLLING MECHANISM FOR LOCOMOTIVES. Eugene L. Ragonnet, Bowdoinham, Me.

4. The combination of a cylinder, a piston, a valve chest connected to a source of fluid under pressure, and to said cylinder, a valve in said chest, means for operating the valve at will, means including a movable member for connecting the piston to the reversing gear of the

engine, a bar fulcrumed on said movable member and also, connected to the valve, and means for operating said valve including an element also connected to said bar and capable of acting as a fulcrum therefor, and a device for limiting the range of movement of said bar in both directions.

930,268. APPARATUS FOR STORING, SUPPLYING AND UTILIZING MINERAL OILS, ETC. JOHN F. CONNELL, Los Angeles, Cal.

3. Apparatus for storing, supplying and utilizing mineral oils, consisting of a storage tank under atmospheric pressure, a service tank under pressure greater than that of the atmosphere, the connections between the storage and service tanks, means for opening and closing said connections, a compressed air reservoir, a separator, a pipe and means for opening and closing communication between the compressed air reservoir and the service tank, a burner, means for connecting the separator to the burner, means for connecting the service tank and separator, a boiler, means for connecting the steam space of the boiler with the burner, a pipe with an opening and closing device at its top connecting the storage tank with a street opening.



PNEUMATIC PATENTS AUGUST 3.

930,273. TIRE-INFLATION MECHANISM. FREDERICK A. DEUNERT, Kayabram, Victoria, Australia.

930,315. PNEUMATIC COUPLER FOR AUTOMATIC MUSICAL INSTRUMENTS. WILLIAM H. REES, Worcester, Mass.

AUGUST 10.

930,379. AIR-BRAKE APPARATUS. LEE L. HOSACK, Youngstown, ALBERT H. GELTZ, Alliance, and WALTER W. MCBANE, Youngstown, Ohio.

930,424. AIR HEATING AND CIRCULATING SYSTEM. CHARLES H. SMITH, Minneapolis, Minn.

930,430. PERCUSSIVE ROCK-DRILL. WILLIAM C. STEPHENS, Cornwall, England.

930,564. METHOD OF OPERATING MULTI-STAGE PRIME MOTORS. PETER G. SCHMIDT, Tumwater, Wash.

1. That method of utilizing a fluid under pressure in the operation of a multi-stage prime motor which consists in subtracting separate portions of such fluid pressure and conducting the same to the successive elements of the motor, each successive portion having a decremental pressure, and renewing the initial pressure supply at intervals determined by the cycle of operation of the motor.

930,567. GAS-COMPRESSOR. THOMAS SHIPLEY, York, Pa.

930,627. SPRAYING APPARATUS. HILLDRETH F. B. SNYDER, Hood River, Oreg.

930,628. AIR-SUCTION CLEANING APPARATUS. ARTHUR H. SQUIER, Philadelphia, Pa.

930,656. AIR AND GAS MIXER. CHARLES A. FORSBERG, Rockford, Ill.

930,781. AIR-PUMP. EDWARD J. MCCUTCHEN, Mexico, Mexico.

930,786. COOLER AND AERATOR. FRANK R. NOONAN, Alexandria, Minn.

930,794. WINDMILL AND CLUTCH THEREFOR. FRITZ W. PIERSON, Missoula, Mont.

930,833. PULSATOR FOR MILKING-MACHINES. DAVID BROWN, Spokane, Wash.

2. In a milking machine, the combination with suction mechanism, an oscillating pulsator for intermittently interrupting the suction and having a spiral groove formed therein, a motor, and means carried by the motor and extended within the groove of the pulsator for actuating the latter.

930,841. INHALER. HUBERT P. COLLINS, East Orange, N. J.

930,843. APPARATUS FOR CONTROLLING THE FLOW OF FLUIDS. SAMUEL COOK, Wilmerding, Pa.

1. In combination with a compressor, a receiver receiving fluid therefrom, a blow-off valve for said receiver, a fluid-actuated supply valve controlling the delivery of fluid to said compressor, a normally balanced controlled valve controlling the delivery of actuating fluid to said supply valve and provided with means whereby it is unbalanced and caused to deliver actuating fluid to the supply when said blow-off valve is opened.

930,851. AIR-BEARING FOR HIGH SPEEDS. SEBASTIAN ZIANI DE FERRANTI, Hampstead, London, England

1. An air bearing having in combination a bearing member; a high speed rotable member; one or more running members disposed between said bearing and said high speed rotatable members together with air lubricated surfaces on coacting bearing portions of said members.

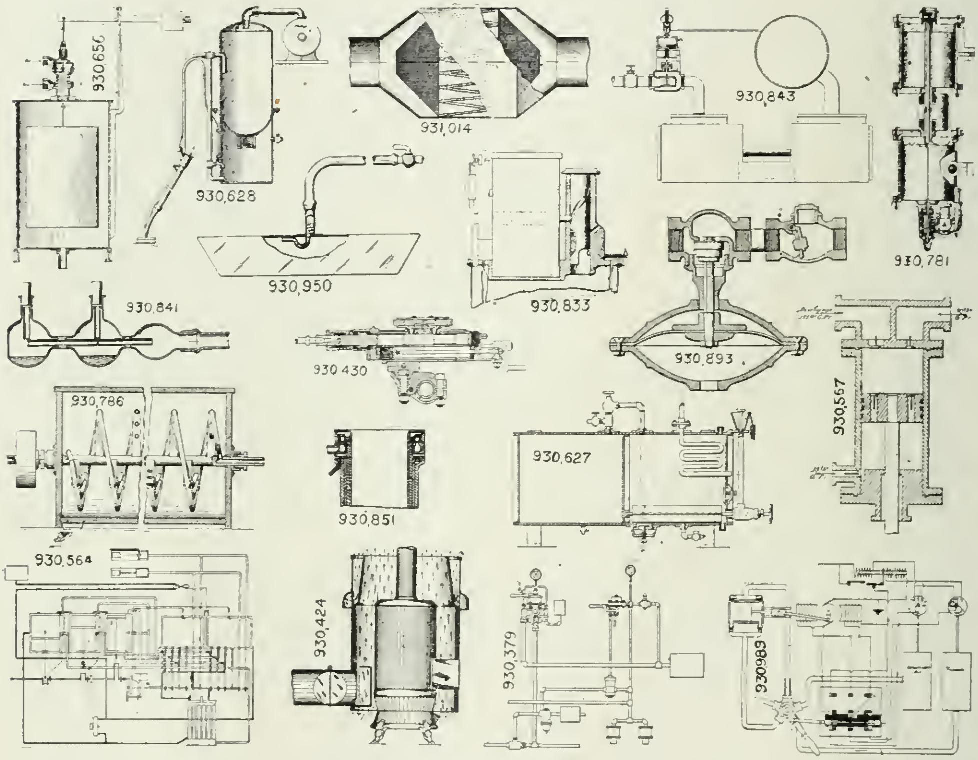
930,893. VACUUM-VALVE FOR HEATING SYSTEMS. Frank Shurtleff, Moline, Ill.

930,950. METHOD OF SEALING VACUUM-JACKETS. John L. Fate, Chicago, Ill.

930,989. CONVERTIBLE SYSTEM OF PRESSURE OR VACUUM CONTROL. Walter J. Richards, Milwaukee, Wis.

931,009. PNEUMATIC LIFE-JACKET. Peter B. Gaudet, Chelsea, Mass.

931,014. AIR-FILTER. MinDelin McGerry, Grand Rapids, Mich.



Pneumatic Patents August 10.

AUGUST 17.

931,026. AERODART. Caesar R. Bannihr, New York, N. Y.

931,030. SPRAYER. D. O. Bowman, Rockford, Mich.

931,039. ROTARY VALVE FOR WIND MUSICAL INSTRUMENTS. Charles G. Conn, Elkhart, Ind.

931,057. MINING APPARATUS. Manning Goldsmith, Atlanta, Ga.

1. In mechanism of the character described, the combination with means for closing the mouth of a mine or similar cavity, of means for introducing a liquid under pressure into said mine or cavity, means for again withdrawing the introduced liquid and dislodged material from said mine or cavity, and means for supplying air under pressure to said mine or cavity.

931,135. PROCESS OF PRODUCING MOTIVE FLUID. Hudson Maxim, New York, N. Y.

931,215. AIR-CHAMBER FOR LIQUID-SPRAYING DEVICES. Adelbert M. Phillips, Le Roy, N. Y.

931,222. PNEUMATIC ELEVATOR. August Rosenthal, West Allis, Wis.

931,225. AIR-SHIP. Reinhold Schmiechen, Newell, Iowa.

931,229. APPARATUS FOR PURIFYING GASES. Francois Sepulchre, Liege, Belgium.

1. An apparatus for purifying blast-furnace and other gases, with a view to the recovery of their by-products, comprising a straight, vertical column, said column receiving the gases at its upper end and being open at its lower end, said lower end being restricted by a central cone to form an annular opening, said opening being immediately over a bath of liquid, an atomizer placed at the top of said column, said atomizer being operated by compressed gas, a spray of liquid from said atomizer descending down said column, a compressor, said compressor taking a portion of the purified gases and delivering them to operate said atomizer, said spray of liquid absorbing the impurities from said gases and being projected therewith into said bath of liquid and a pipe for the escape of the purified gases.

931,234. AIR-BRAKE SYSTEM. Edwin M. Swift, Ballard, Wash.

931,240. ATOMIZER. Robert F. Venner and Arthur W. Brown, London, England.

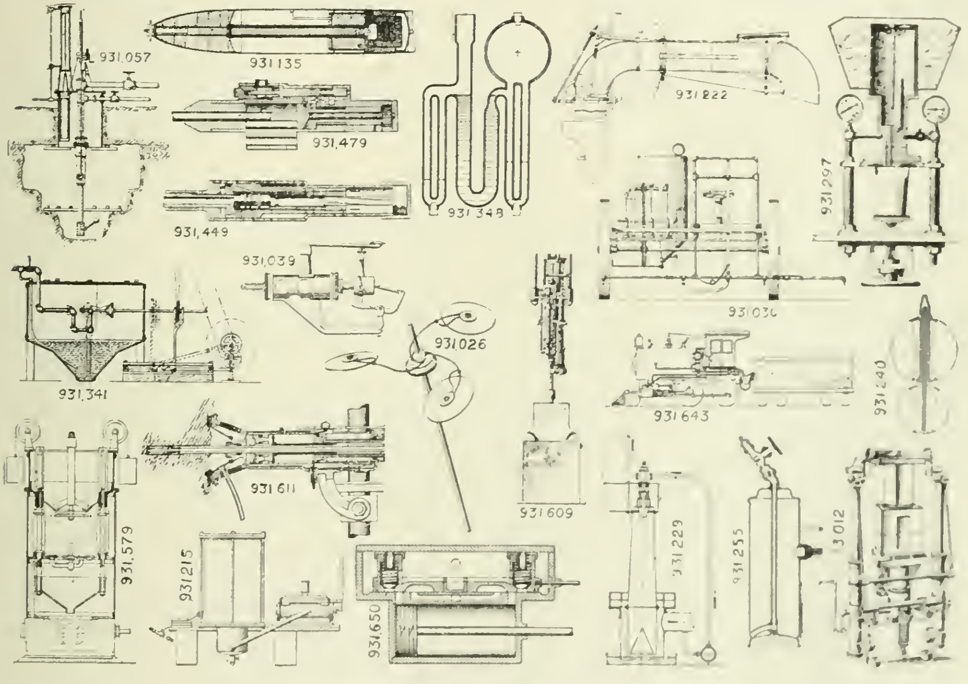
931,255. FIRE-EXTINGUISHER AND OTHER AIR-PRESSURE LIQUID-EJECTING VESSEL. Henry T. Blake, Ross, England.

931,297. APPARATUS FOR DRAWING BEER. Lucien H. Handy and Walter L. Phillips, San Francisco, Cal.

931,341. BLASTING DEVICE. Jacob Phillips, Bellaire, Ohio.
931.348. BLAST AND PRESSURE METER. Edward H. Schulz, Fort Wadsworth, N. Y.
931,449. PERCUSSION-ENGINE. Wilhelm Mauss, Brakpan, Transvaal.
931,479. ROCK-DRILL. William E. Porter, Bisbee, Ariz.
931.579. SAND-BLAST BLOWER. Diederich A. M. Doublet, Eimsbuttel, near Hamburg. Germany.
931,609. FLUID-PRESSURE HAMMER. Leslie E. Howard, La Grange, Ill.
931,611. ROCK-DRILL OR BORING-TOOL. John Hutchings, London, England.
931,643. AIR MOTOR OR LOCOMOTIVE. James I. Pittman and Elizabeth Harrison, Valdosta. Ga.
931.648. INNER TUBE OF PNEUMATIC TIRES. Harry K. Raymond, Akron, Ohio.
931,650. AIR-VALVE GEAR. Edward A. Rix, San Francisco, Cal.
13,012. JARRING-MACHINE. Wilfred Lewis, Philadelphia, Pa. (Reissue).
931,845. HUMIDIFIER. Frank B. Comins. Sharon, Mass.
931.942. TRIPLE VALVE FOR AIR-BRAKES. William B. Mann, Baltimore, Md.
931,964. INTERNAL-COMBUSTION ROCK-DRILL. Lewis L. Scott, Joplin, Mo.
932,068. SUCTION-HEAD FOR VACUUM COTTON-PICKERS. John S. Thurman. St. Louis, Mo.
932.124. MINING-MACHINE. John Herzler, Henry Henninger. and William Fenner, Belleville, Ill
932,143. AIR-PUMP. August M. Kjaersgaard, Copenhagen, and Carl S. J. Wiese, Odense, Denmark.
932,221. AERATING AGITATOR FOR LIQUIDS. Richard D. Winship, Chicago, Ill.
932,421. VALVE SYSTEM FOR HAMMERS. Chester B. Albree, Pittsburg, Pa.

AUGUST 31.

932.504. FLUID-PRESSURE-INDICATING DEVICE. Thomas Sloper, Devizes, England.



Pneumatic Patents August 17.

AUGUST 24.

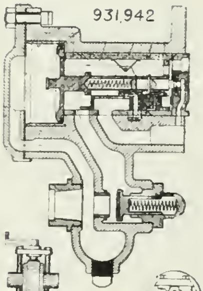
931,757. PNEUMATIC MACHINERY-CLEANER. Edward Harmer, Ottawa, Ontario.
931,779. FLUID-CONTROLLED DRILL-BIT SWAGING AND SHARPENING MACHINE. John G. Leyner, Denver, Colo.
931,797. VALVE. Frank R. Phillips and Rex G. Averill, Mansfield. Ohio.

1. In a sander valve, a body provided with a casing, means to open and close the valve, an oscillating lever secured to the valve, a removable operating lever interposed between the oscillating lever and valve stem, both of said levers being adapted to be moved through the medium of the operating handle of the engineer's air brake valve.

931,798. AUTOMATIC BRAKE-APPLYING MECHANISM. Franklin A. Pierce. Wheeling, W. Va.
932,520. PORTABLE SPRAYING APPARATUS. Dwight W Wadsworth, Bangor, Mich.
932,521. WIND-WHEEL FOR WINDMILLS Hugh M. Wallace, Clovis, N Mex
932,686. DRY SEPARATOR FOR DUST REMOVING APPARATUS Ralph F. Diserens Bradford, Pa
932,689. PROCESS OF OXIDIZING ORES Byron E Eldred, Bronxville, N Y

1. The process of treating sulfied ores which consists in oxidizing such ores with draft currents of air diluted with controlled proportions of non-oxidizing gases.

932,711. TEMPERATURE-REGULATING SYSTEM. Charles D. Knight, Schenectady, and Walter O Lum, Amsterdam, N Y
932,712 AIR-SHIP Enoch S Le Fevre, Littlestown, Pa., and William D Le Fevre, Smyrna Del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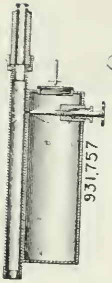
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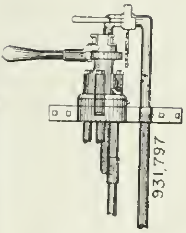
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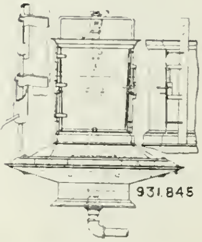
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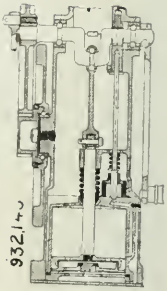
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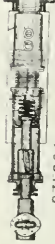
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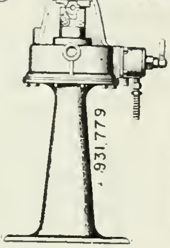
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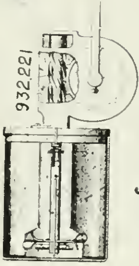
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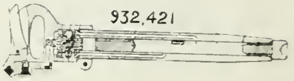
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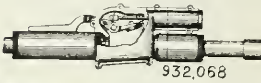
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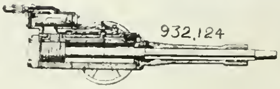
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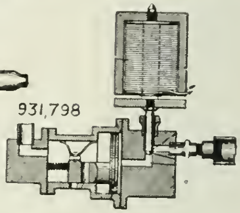

931,798

Pneumatic Patents August 24.

932,761. CAR-VENTILATING SYSTEM. Dwight I. Cooke, Chicago, Ill.

932,885. SPEED-GAGE. Orson D. Munn and John K. Brachvogel. New York, N. Y.

1. A speed gage, comprising a cylinder having communicating openings, a piston mounted within said cylinder between said openings, indicating means controlled by said piston, and a blower in said cylinder adapted to force air against said piston.

932,916. APPARATUS FOR REMOVING GASES AND FOUL AIR FROM MINES. Joseph C. Stirling, Bakerstown, Pa.

932,934. AIR-LIFT. Robert N. Wood, Point Richmond, Cal.

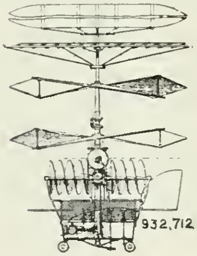
932,947. COMBINED LIGHTING AND HEATING SYSTEM. Homer A. Barr, Ashland, Pa.

932,997. ACETYLENE-GAS APPARATUS. Lars J. Olson, Alexandria, Minn.

932,999. AIR-SHIP. Joseph A. Rignon, Berlin, Germany.

933,003. NOZZLE FOR VACUUM-CLEANERS. John W. Smith, Philadelphia, Pa.

933,034. COMPRESSED-AIR DOOR-CLOSER. Albert E. Hanson, Wakefield, Mich.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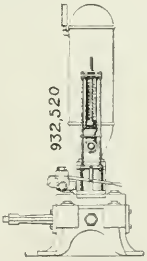
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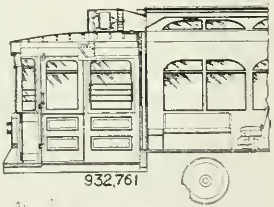
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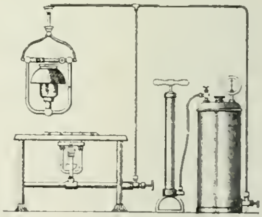
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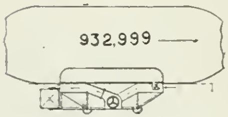
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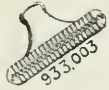
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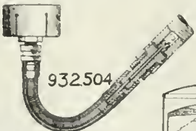
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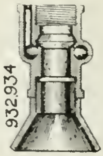
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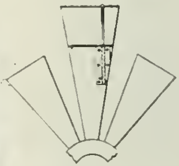
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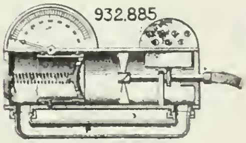
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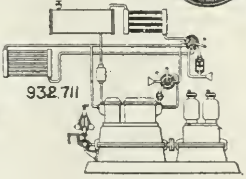
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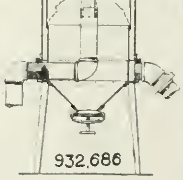
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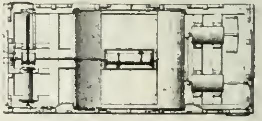
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Pneumatic Patents August 31.

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC.

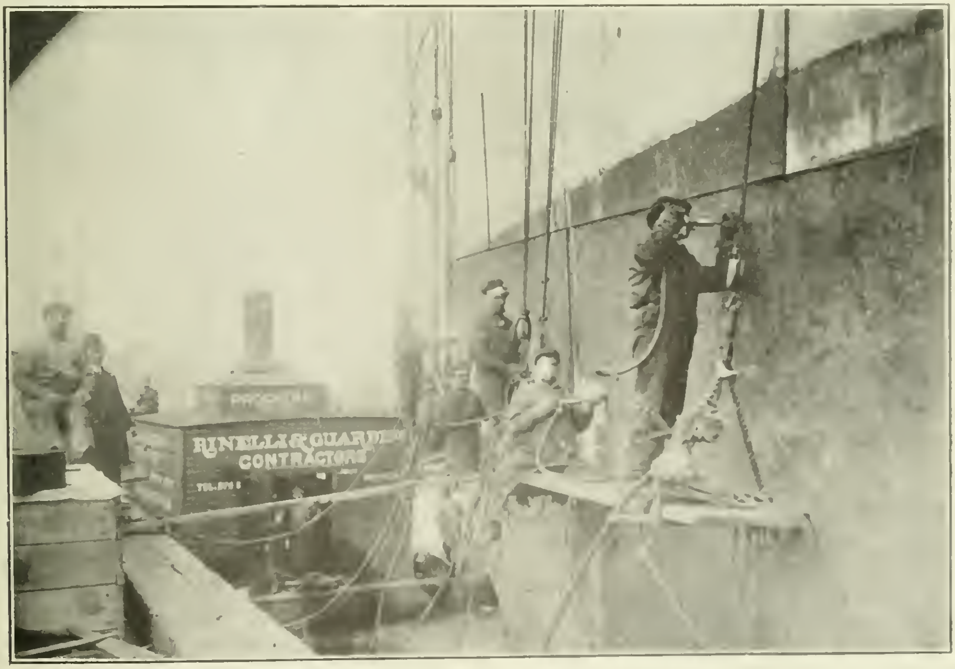
Vol. XIV NOVEMBER, 1909 No. 11

PNEUMATIC TOOLS CLEANING STEEL SURFACE

The half tone herewith tells its own story, and requires scarcely a word of explanation. It shows half a dozen men using "Imperial" pneumatic scaling hammers on the side of the Alaska of the Hawaiian Steamship Company as she lies at her dock in New York harbor.

The advent of the "pneumatic tool" in its various forms, as adapted to different classes of work, has resulted in the development of new trades or specialized lines of industry. As here indicated, a pushing firm of contractors have fitted up a scow or float with the necessary apparatus and stand constantly ready to take jobs such as here shown of cleaning the exposed surfaces of steamers from old paint, scale and rust and then repainting them. In connection with this work divers are furnished who can use the same or similar tools under water for removing barnacles or incrustations which as they accumulate materially reduce the running speed and entail extra pull on the coal bunkers.

The advantage to the ship owner by this



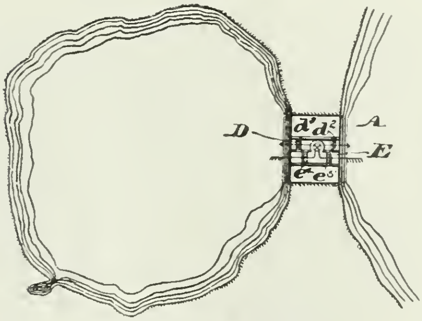
PNEUMATIC TOOLS CLEANING A STEAMER'S SIDES.

arrangement is important. The time and expense of dry-docking are saved and the work as here shown is not only more cheaply done but it may almost entirely be accomplished while loading or unloading is going on.

TIDAL AIR COMPRESSION

By W. O. Webber.

Along the coast of Maine a large number of tidal basins exist. The same is largely true of the coast lines in the balance of the United States and of other countries in the temperate zones. If we place a dam across the outlets of either of these coastal indentations, holding the water in a so-called mill pond, the outflow and inflow can be utilized in the manner here to be described:



TIDAL BASIN WITH DAM.

Fig. 1 is a plan of the inlet and outlet passageways, with the necessary gates. Fig. 2 is a vertical section on the line 2-2 of Fig. 1. Fig. 3 is an enlarged vertical elevation on the lines 3-3 of Fig. 1.

1 is the inlet passageway, 2 is the outlet passageway, 3 is the longer leg and 4 the shorter leg of an inverted siphon connecting the inlet and outlet passageways. The grade of the bottom of the outlet passageway 2 is below that of the inlet passageway 1. 4 is preferably made of a larger area than 3. 5 and 5*a* are inwardly opening gates situated in the inlet passageway, and 6 and 7 are outwardly opening gates situated in the outlet passageway. 8 is an enlarged separating chamber, situated at the bottom of the inverted siphon, and 9 is an abutment wall transversely situated in said chamber. 10 are pontoons situated in the inlet passageway 1, carrying fulcrums 11, on which are pivoted weighted levers 12. One end of these levers is pivoted to beams 13, which support transversely disposed beams 14, which, in turn, support downwardly depending air pipes 15. These air pipes are adjustably located by the collars 16. Upon the side of the inlet passageway 1 are located stop blocks 17. Rising from the upper part of the separating chamber 8 is a service pipe 18, provided with a stop valve 19.

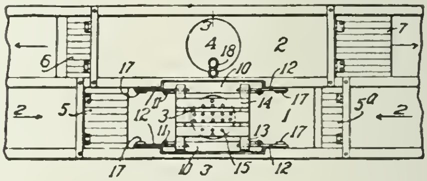


Fig. 1

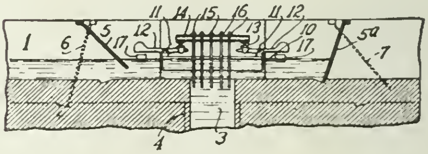


Fig. 2

The operation is as follows:

These two passageways are transversely disposed through a dam which spans the neck of a tidal basin. If, now, we assume that the water impounded in a tidal basin enters the inlet passageway 1, from the left, as shown by the arrows, it will automatically swing open the inlet gate 5, pass down the long leg of the siphon 3, and in passing in and around the vertically depending air pipes 15 entrain air with the water. The descending column of air and water then impinges upon the transversely disposed abutment wall 9, at the bottom of the siphon, which causes the air to be rapidly freed from the water. This air then is caught and held by the pocket, or air chamber 8, while the water passes around the ends of the abutment wall 9, and thus into the shorter and larger leg of the siphon 4, then flows upward into the outlet passageway 2, forcing open the gate 7 and passing into the ocean, the gate 5*a* in the inlet passageway and the gate 6 in the outlet passageway being held tight by the pressure of water against them.

Upon the reversal of the tide, so that it flows from the right into the inlet passageway 1, the gate 5*a* is automatically forced open, the gate 5 is shut, the water and entrained air flow down the longer leg of the siphon, as before, up the shorter leg, and, shutting the gate 7, force open the gate 6, thereby emptying into the tidal basin.

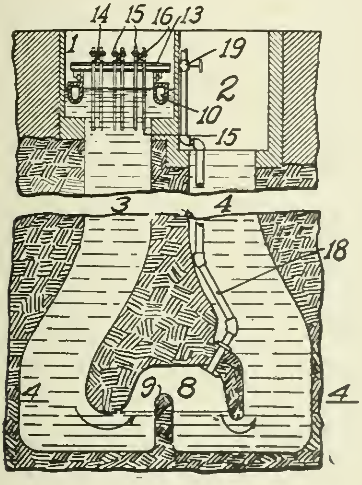


FIG. 3

As the water falls in either the tidal basin or the ocean the water will correspondingly fall in the inlet passageway 1, and the air inlet pipes will descend as the level of the water falls in the inlet passageway, thus maintaining the lower ends of these inlet pipes at a constant depth below the surface of the water in the inlet passageway. This would continue until the flotation tanks 10 rested upon the bottom of the passageway, when any further fall of the water would vary the submersion. To overcome this, just before the bottom of the flotation tanks would strike the bottom of the inlet passageway, the outer ends of the levers 12 are brought into contact with the stops 17, causing the frame carrying the inlet pipes to descend at a faster rate, in proportion to the leverage, thus obtaining an increased rate of submersion at the lower depth of water in the inlet passageway. This mechanism will result in this apparatus continuing in an operative state with a very small difference in the level of the tide, and it also provides an automatically starting, stopping and operative device.

POWER COSTS.

The cost of a horse-power from steam engines of large capacity (say a thousand horsepower or over) on a ten-hour basis three hundred and eight days in a year, with coal at $3 per ton, is $23.25. This is equal to $46 per year on a twenty-four-hour basis three hundred and sixty-five days in the year.

An electrical horse-power on the latter basis, directly at the place of generation and obtained from falling water, costs $15.24. Our hydraulic compressed air horse-power at the dam costs $8.25, or about one-half the cost of electric power, and one-third the cost of steam power.

Our air power transmitted by a pipe line to a point four miles from its source costs $9.05, and electrical power transmitted four miles costs $16.49. At a distance of twenty miles from a source, air power costs $13.15 and electric power $19.21.

Small consumers of steam can afford to pay anything less than one-half of the following tabulated figures for air under pressure to use in their engines, as in these figures practically one-half the cost is fuel and the other half general expense, maintenance, attendance, etc.

	Cost of 1 H. P. [illegible]				Cost [illegible] H. P. [illegible]			
	$2	$3	$4	$5	$2	$3	$4	$5
Triple expansion pump, Allis, [illegible] revolutions	45	55	61	[illegible]	31	[illegible]	[illegible]	[illegible]
Triple expansion pump, Allis, [illegible] revolutions	27	33	39	45	16	[illegible]	[illegible]	[illegible]
Compound [illegible] best	22	36	44	52	[illegible]	[illegible]	[illegible]	24
" average	[illegible]	47	52	[illegible]	22	[illegible]	25	[illegible]
" electric light average	122	[illegible]	[illegible]	174	[illegible]	[illegible]	[illegible]	[illegible]
" trolleys	45	[illegible]	[illegible]	[illegible]	[illegible]	32	[illegible]	[illegible]
Triple expansion trolley	45	54	64	74	26	[illegible]	[illegible]	[illegible]
Condensing mill	44	52	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Non-condensing mill [illegible]	[illegible]	[illegible]	81	88	42	[illegible]	[illegible]	[illegible]

TABLE OF STEAM POWER COSTS.

A further discussion of this means of obtaining power and the tests made on such plants may not be uninteresting.

MOISTURE IN AIR.

Air compressed by the ordinary methods of mechanical compression contains at least the same amount of moisture as the surrounding atmosphere from which it was compressed; and in parting with the heat necessarily contributed to the air by mechanical compression there is incidentally a considerable loss of energy. Air compressed directly by falling water is kept at the same temperature as this water. It is compressed isothermally, and the consequent expansion, when used in motors, produces an almost truly adiabatic expansion line. Tests, however, have shown that air compressed in this manner contains only one-sixth of the moisture originally in the surrounding atmosphere from which it is compressed. This is probably because the moisture in the bubble of air is pressed or squeezed out to its surface and then absorbed by the surrounding water. Incidentally there is no loss of power in parting with any heat, and there is a practical result which is of more importance—the hydraulically compressed air can be expanded in use down to a temperature much below the freezing point, while atmospheric air, with the usual amount of moisture, mechanically compressed, often cannot be used at all, owing to the freezing up of the exhaust passages of the motor in which the attempt to use it is being made.

ADAPTABILITY.

The adaptability of compressed air for various uses is very great. While electricity supplies power and light very directly, it cannot be used for heating except at a prohibitive cost. Gas is used very directly to supply heat, power and light, but is expensive for heating and power at the prices generally charged. City water pressure can be used to supply power, and indirectly light, by the use of a water motor driving a dynamo, but is too expensive for most purposes. Steam supplies heat and motive power almost directly, and indirectly light through a dynamo. It is, however, more expensive than compressed air, and involves more risk and attention. Compressed air can be used directly as a source of motive power, ventilation and refrigeration, also in the operation of elevators. It is particularly advantageous to use in storehouses and warehouses for the operation of the elevators and any other machinery which it may be desirable to locate in such a building, owing to the fact that there would be no danger of its freezing up and there would be no necessity of keeping the building warm in consequence, and also from the fact that there would be no fire risk due to pipes coming in contact with woodwork, as might be the case if steam pipes were used.

In fact, with enclosed self-oiling bearings, compressed air would offer the only practical power which might be used in the interior of a powder magazine.

Air has been transmitted for considerable distances and under a great range of pressures. At the Mont Cenis Tunnel, air was transmitted to the boring machinery 20,000 feet, under a pressure of 105 pounds per square inch. In the installation at Paris in 1881, by M. Popp, the length of the pipes slightly exceeded twenty-four miles, the main is a steel pipe 20 inches in diameter, and the air, maintained at 90 pounds pressure, transmits 6,000 horse-power.

At Offenbach, near Frankfort-on-the-Main, air is distributed through 25,000 feet of cast iron pipe under 90 pounds pressure. At the Portsmouth Dock Yards, England, air is transmitted through 14,000 feet of pipe, varying from 3 to 12 inches in diameter, under 60 pounds pressure, and is used to drive forty 7-ton capstans, five 20-ton cranes and machinery for working seven caissons.

There is also a large compressed air plant at the Terni Steel works in Central Italy. In this plant 1,200,000 feet of air per day, under 75 pounds pressure, are used to drive a 100-ton hammer, a 100- and 150-ton crane and numerous engines.

In this country 2,500,000 cubic feet of air per day, at 60 pounds pressure, delivering 1,700 horse-power, are used at the Chapin mines in Michigan. The mains in this plant are 24-inch wrought-iron pipes, one-quarter inch thick. Very successful compressed air tramways have been operated for a number of years at Berne, Switzerland, and at Nantes, France.

We have already mentioned its use in connection with power hammers, cranes and motors. For drying purposes it is even more efficient than heat. Compressed air is also largely susceptible to double uses. For instance, after it has been used cold, or without preheating expansively in a motor to produce power, the exhaust furnishes an efficient and cheap method of producing refrigeration.

In the transmission of compressed air over long distances, the loss of pressure due to friction in pipes of proper sizes, and the loss due to leakage in properly constructed pipes and joints are very small. Velocities of from 30 to 50 feet per second are allowable. When an air distribution system is introduced into a thickly settled community, the safety from the air main is very much greater than from a steam main or a water main under pressure and the leakage or even the bursting of such a pipe is attended with very much less damage.

Another great advantage in such a case is that power users require no new plant, and need incur no outlay for motors. Their present steam engines, with little or no alteration, are admirably adapted for serving as air motors.

Tests of small motors of from one to two horse-power, using air at the ordinary atmospheric temperature and at 735 pounds per square inch absolute, exhausting at from 33 degrees to 54 degrees, required a consumption of 1,200 cubic feet of air per brake horse-power per hour. At the Berne tramway the air is compressed to 450 pounds per square inch. On the average the cars use about 35 pounds of air per car-mile. This, however, is used in connection with hot water. In small motors of from one to two horse-power, with the air pre-heated to a temperature of about 158 degrees and exhausting at about the freezing point, or 32 degrees, 850 cubic feet of air per brake horse-power per hour were used.

In some very carefully conducted trials made by Professor Riedler, using an 80 horse-power engine which was actually giving 72 indicated horse-power, using air at 80 pounds pressure, heated to 320 degrees, with cylinders jacketed with hot air and exhausting at about 95 degrees, about 425 cubic feet of air per brake horse-power per hour were used. This showed an efficiency of about 92 per cent.

During some tests made at Magog in September, 1899, owing to the condition under which these tests were made, the change in the humidity on the air was not so great as above stated. The moisture in the external air showed 90 per cent. of saturation, and after compression 29 per cent., or a little more than one-quarter. In the Magog tests, using an old 75 horse-power Corliss engine, with air at 53½ pounds gage pressure, with cold air direct from the compressor at from 66 degrees to 73 degrees and exhausting down to the extremely low point of 42 degrees below zero, 850 cubic feet of air per brake horse-power per hour were used; and with the air preheated to from 205 degrees to 295 degrees Fahrenheit, and exhausting at from 67 degrees to 68 degrees, 620 cubic feet of air per brake horse-power per hour were used.

These figures show conclusively that while water power for direct consumption at the site of the waterfall is the cheapest known form of power, yet for transmission purposes, hydraulically compressed air offers a means of transporting power and gives results cheaper than electricity, and that both electrical transmission and compressed air transmission from water powers are cheaper than steam power.

The compressed air transmission also has a further advantage in the fact that in order to utilize it, it is not necessary to go to an expensive outlay for electric motors, as the compressed air can be used directly in steam engines without requiring any alteration to be made in them.

AN ELECTRICAL BAROMETER

An English inventor, Mr. P. B. Goldschmidt, has invented an electrical device by which the fluctuations of the mercury in a barometer are indicated with minute accuracy. A v-shaped carbon filament passes down through the Torricellian vacuum, the apex being submerged in the mercury. The two ends of the filament pass through the glass of the barometer tube at different points and are connected, one with the cathode, the other with the anode of a battery, a galvanometer being in the circuit. If the barometer rises the current has a less length of carbon filament to traverse and the galvanometer shows an increased current, with a reverse effect if the barometer falls, the mercury never falling entirely out of contact.

To eliminate the effect of changes of temperature, a thermometer, provided with a carbon filament in the same way as the barometer is included in the circuit. At each reading a known resistance is added to the circuit sufficient to bring the galvanometer to the null point and from this resistance the height of the barometer can be determined to the tenth of a millimeter (.004 in.)

This Goldschmidt barometer confirms the fact, long suspected but which the ordinary barometer cannot tell us, that the atmospheric pressure is continually varying, being hardly ever the same for five minutes at a time.

ROCK DRILLS ON THE RAND.

The recently published statistics of the Mines Department show in a striking way how large is the field for rock drills upon the Rand both in stoping and development work. According to these records 66,047 feet of development were accomplished in the producing mines and 16,388 feet in the non-producing mines during the month of July, making a total altogether of 82,435 feet, or, say, near 16 miles. Some 2,210,271 tons of rock were hoisted from all mines. The average number of rock drills in use was 2,868, of which number the producing mines employed no less than 2,655. Large as the figure is, and indicative of the enormous amount of money represented by the air-drill installations of the Rand, it is steadily growing, for only to go as far back as the preceding month of June, there were during that period on all mines on the Rand an average of 2,662 rock drills in use, showing an increase for the month of 206 machines. Admitting that this may be an exceptional rate of increase, it is nevertheless evident upon all sides that the rock drill is going to be a factor of rapidly growing importance in the mines of the Rand. As might be expected, every endeavor is being made to achieve and break records, not only at the development faces but on the stopes. Scarcely a month passes but a new record is announced, and so far in development work the 3¼ inch Ingersoll-Sergeant rock drills have been putting up a speed at this kind of work, which is solidly supporting the excellent reputation which the company long since attained in this department of mining. To take some instances that have come to hand within the last nine months, say,

Given Ratio.	Recip. Ratio.	H	Recip.	J	Recip.	K	Recip.	L	Recip.	M	Recip.	N	Recip.
0.01	100	0.0561	17.825	0.0308	32.467	0.0500	20.000	0.0465	21.505	0.0210	47.619	0.0404	24.752
0.02	50	0.0982	10.018	0.0591	16.920	0.0894	11.185	0.0798	12.531	0.0399	25.313	0.0708	14.124
0.03	33.33	0.1352	7.395	0.0860	11.628	0.1245	8.032	0.1085	9.217	0.0577	17.330	0.0974	10.266
0.04	25.00	0.1688	5.924	0.1171	8.952	0.1566	6.385	0.1341	7.457	0.0747	13.387	0.1215	8.230
0.05	20.00	0.1998	5.005	0.1365	7.326	0.1866	5.359	0.1577	6.334	0.0910	10.989	0.1438	6.954
0.06	16.667	0.2288	4.371	0.1604	6.234	0.2148	4.655	0.1796	5.567	0.1068	9.363	0.1647	6.071
0.07	14.286	0.2562	3.903	0.1836	5.446	0.2415	4.140	0.2002	4.995	0.1222	8.183	0.1844	5.423
0.08	12.50	0.2821	3.544	0.2061	4.852	0.2669	3.746	0.2196	4.553	0.1371	7.294	0.2032	4.921
0.09	11.111	0.3067	3.260	0.2280	4.386	0.2912	3.434	0.2382	4.198	0.1517	6.592	0.2211	4.522
0.10	10.00	0.3303	3.027	0.2493	4.011	0.3145	3.179	0.2558	3.909	0.1659	6.027	0.2383	4.280
0.11	9.09	0.3528	2.834	0.2701	3.702	0.3368	2.969	0.2728	3.665	0.1798	5.561	0.2548	3.924
0.12	8.333	0.3744	2.679	0.2903	3.444	0.3583	2.791	0.2891	3.459	0.1935	5.167	0.2708	3.692
0.13	7.692	0.3952	2.533	0.3100	3.258	0.3790	2.638	0.3049	3.279	0.2069	4.833	0.2862	3.494
0.14	7.143	0.4153	2.407	0.3293	3.036	0.3990	2.506	0.3201	3.124	0.2201	4.543	0.3012	3.320
0.15	6.667	0.4346	2.301	0.3481	2.872	0.4183	2.390	0.3348	2.986	0.2331	4.290	0.3157	3.167
0.16	6.25	0.4532	2.206	0.3665	2.728	0.4370	2.288	0.3491	2.864	0.2458	4.068	0.3298	3.032
0.17	5.882	0.4712	2.122	0.3845	2.601	0.4552	2.197	0.3629	2.755	0.2584	3.870	0.3436	2.910
0.18	5.556	0.4887	2.046	0.4020	2.487	0.4727	2.115	0.3764	2.656	0.2708	3.692	0.3570	2.801
0.19	5.263	0.5055	1.978	0.4192	2.385	0.4897	2.042	0.3896	2.567	0.2830	3.533	0.3700	2.702
0.20	5.00	0.5219	1.904	0.4360	2.293	0.5062	1.975	0.4024	2.485	0.2950	3.390	0.3828	2.612
0.21	4.762	0.5377	1.859	0.4524	2.210	0.5223	1.914	0.4149	2.410	0.3069	3.258	0.3953	2.529
0.22	4.545	0.5531	1.808	0.4685	2.134	0.5378	1.859	0.4271	2.341	0.3186	3.138	0.4075	2.454
0.23	4.348	0.5680	1.760	0.4842	2.065	0.5530	1.808	0.4390	2.277	0.3302	3.028	0.4194	2.384
0.24	4.167	0.5825	1.716	0.4996	2.001	0.5677	1.761	0.4507	2.209	0.3416	2.927	0.4312	2.319
0.25	4.00	0.5966	1.676	0.5147	1.942	0.5820	1.718	0.4621	2.164	0.3529	2.833	0.4426	2.259
0.26	3.846	0.6102	1.638	0.5295	1.888	0.5959	1.678	0.4733	2.112	0.3641	2.746	0.4539	2.203
0.27	3.704	0.6235	1.604	0.5439	1.838	0.6094	1.641	0.4843	2.066	0.3752	2.665	0.4650	2.150
0.28	3.571	0.6364	1.571	0.5580	1.792	0.6226	1.606	0.4950	2.020	0.3861	2.590	0.4759	2.101
0.29	3.448	0.6490	1.541	0.5718	1.748	0.6355	1.573	0.5056	1.977	0.3970	2.519	0.4866	2.055
0.30	3.333	0.6612	1.512	0.5854	1.708	0.6479	1.543	0.5160	1.938	0.4077	2.453	0.4971	2.011
0.31	3.226	0.6731	1.485	0.5986	1.670	0.6601	1.515	0.5262	1.900	0.4183	2.391	0.5074	1.970
0.32	3.125	0.6846	1.461	0.6116	1.635	0.6719	1.488	0.5362	1.865	0.4288	2.332	0.5176	1.932
0.33	3.03	0.6959	1.437	0.6243	1.602	0.6835	1.463	0.5461	1.831	0.4393	2.276	0.5276	1.895
0.34	2.941	0.7068	1.414	0.6367	1.570	0.6947	1.439	0.5558	1.799	0.4496	2.224	0.5374	1.861
0.35	2.857	0.7174	1.394	0.6489	1.541	0.7056	1.417	0.5653	1.768	0.4598	2.177	0.5471	1.827
0.36	2.778	0.7278	1.374	0.6608	1.513	0.7163	1.396	0.5747	1.757	0.4700	2.127	0.5567	1.796
0.37	2.703	0.7379	1.355	0.6724	1.487	0.7267	1.376	0.5839	1.712	0.4800	2.083	0.5662	1.766
0.38	2.632	0.7477	1.337	0.6838	1.462	0.7368	1.357	0.5930	1.686	0.4900	2.040	0.5755	1.737
0.39	2.564	0.7572	1.321	0.6949	1.439	0.7466	1.339	0.6020	1.661	0.4999	2.000	0.5846	1.710
0.40	2.50	0.7665	1.304	0.7058	1.416	0.7562	1.322	0.6109	1.636	0.5097	1.961	0.5937	1.684
0.41	2.439	0.7756	1.289	0.7165	1.395	0.7656	1.306	0.6196	1.613	0.5194	1.925	0.6026	1.659
0.42	2.381	0.7844	1.274	0.7269	1.375	0.7747	1.291	0.6282	1.592	0.5291	1.890	0.6115	1.633
0.43	2.326	0.7929	1.261	0.7370	1.356	0.7835	1.276	0.6367	1.570	0.5386	1.856	0.6202	1.612
0.44	2.273	0.8012	1.248	0.7470	1.338	0.7921	1.262	0.6451	1.550	0.5481	1.824	0.6288	1.590
0.45	2.222	0.8093	1.235	0.7567	1.321	0.8005	1.249	0.6533	1.580	0.5576	1.793	0.6373	1.569
0.46	2.174	0.9172	1.223	0.7662	1.305	0.8087	1.236	0.6615	1.510	0.5670	1.763	0.6457	1.548
0.47	2.128	0.8249	1.212	0.7754	1.289	0.8166	1.224	0.6696	1.493	0.5762	1.735	0.6540	1.529
0.48	2.083	0.8323	1.201	0.7845	1.274	0.8244	1.213	0.6775	1.476	0.5855	1.708	0.6622	1.510
0.49	2.041	0.8395	1.191	0.7933	1.265	0.8319	1.202	0.6854	1.459	0.5947	1.681	0.6703	1.492
0.50	2.00	0.8466	1.181	0.8019	1.247	0.8392	1.191	0.6932	1.442	0.6038	1.656	0.6784	1.474

TABLE OF MEAN EFFECTIVE PRESSURE RATIOS IN THE ADIABATIC it may be mentioned that at the Van Dyk Mine in November of last year two 3¼ in. Ingersoll drills drove 323 feet in 62 shifts of 9½ hours each. This work was performed at the No. 1 shaft, 5th level east, by two miners named Karlson and Kerr. One white man and five natives worked each shift using two Ingersoll Sergeant drills. At the New Modderfontein G.M. Company, on the 7th level of No. 12 shaft, Messrs. Corris and McHenry, with two 3¼ in. Ingersoll-Sergeant drills, drove during May 267 feet, June 264 feet, and July 295 feet, a total of 826 feet for 156 consecutive shifts. This was a record for consecutive working. At the same mine, in a 11 feet by 8 feet cross-cut, on the 8th level, Mr. Langridge, with two 3¼ inch Ingersoll-Sergeant drills drove 270 feet in 49 single shifts.—*South African Mining Journal.*

MEAN EFFECTIVE PRESSURES IN AIR COMPRESSION OR EXPANSION

By Frank Richards.

The accompanying table and diagram, in connection with those previously given (page 5427), offer special facilities for power computations in connection with the compression or the working expansion of air. The former dealt with the inter-dependent ratios of pressure, volume and temperature, either of which being given, the others were readily derivable therefrom.

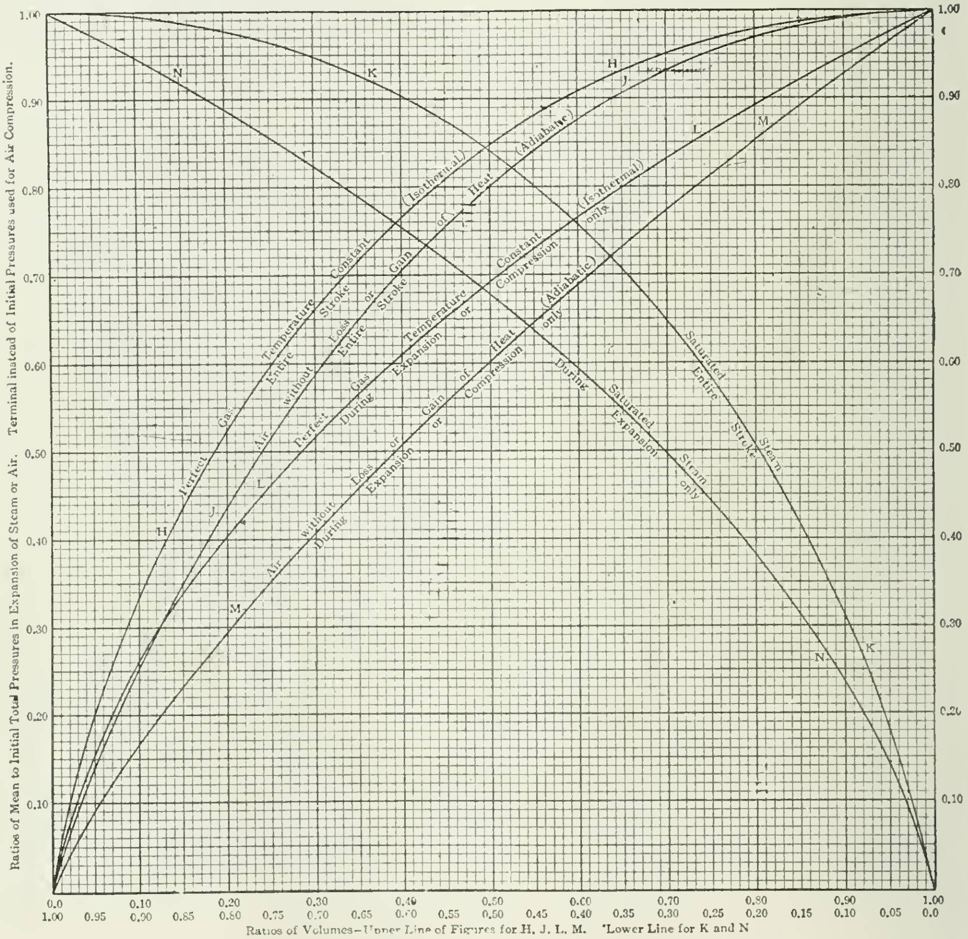
In the table and diagram here presented the given ratio is that of the volumes at the beginning and the end of the stroke. From that is readily determined the mean effective pressure ratio,* either during the entire stroke or during compression or expansion only. On

Given Ratio.	Recip. Ratio.	H	Recip.	J	Recip.	K	Recip.	L	Recip.	M	Recip.	N	Recip.
0.51	1.961	0.8534	1.171	0.8103	1.234	0.8463	1.181	0.7008	1.426	0.6128	1.631	0.6863	1.457
0.52	1.923	0.8600	1.163	0.8185	1.222	0.8532	1.172	0.7084	1.410	0.6218	1.608	0.6941	1.441
0.53	1.887	0.8665	1.154	0.8264	1.210	0.8599	1.162	0.7159	1.396	0.6307	1.585	0.7019	1.424
0.54	1.852	0.8727	1.147	0.8342	1.191	0.8664	1.154	0.7234	1.382	0.6396	1.563	0.7096	1.409
0.55	1.818	0.8788	1.137	0.8418	1.188	0.8727	1.145	0.7307	1.368	0.6484	1.542	0.7172	1.394
0.56	1.786	0.8847	1.130	0.8492	1.177	0.8789	1.137	0.7380	1.355	0.6572	1.521	0.7247	1.379
0.57	1.754	0.8904	1.123	0.8563	1.167	0.8848	1.130	0.7451	1.342	0.6659	1.501	0.7322	1.365
0.58	1.724	0.8959	1.116	0.8633	1.158	0.8906	1.122	0.7522	1.329	0.6745	1.482	0.7396	1.352
0.59	1.695	0.9013	1.109	0.8701	1.149	0.8962	1.115	0.7593	1.317	0.6831	1.463	0.7469	1.338
0.60	1.667	0.9065	1.103	0.8767	1.140	0.9017	1.109	0.7662	1.305	0.6917	1.445	0.7541	1.326
0.61	1.639	0.9115	1.097	0.8831	1.130	0.9069	1.102	0.7731	1.293	0.7002	1.428	0.7613	1.313
0.62	1.613	0.9164	1.091	0.8893	1.124	0.9120	1.096	0.7800	1.282	0.7086	1.411	0.7684	1.301
0.63	1.587	0.9211	1.085	0.8953	1.116	0.9169	1.090	0.7867	1.271	0.7170	1.394	0.7755	1.289
0.64	1.563	0.9256	1.080	0.9011	1.109	0.9217	1.085	0.7934	1.259	0.7254	1.378	0.7824	1.278
0.65	1.538	0.9300	1.075	0.9068	1.102	0.9263	1.079	0.8000	1.250	0.7337	1.362	0.7894	1.266
0.66	1.515	0.9342	1.070	0.9123	1.096	0.9307	1.074	0.8066	1.239	0.7419	1.347	0.7962	1.256
0.67	1.493	0.9383	1.065	0.9176	1.089	0.9350	1.069	0.8131	1.229	0.7501	1.333	0.8030	1.245
0.68	1.471	0.9423	1.061	0.9227	1.083	0.9391	1.064	0.8196	1.220	0.7583	1.320	0.8097	1.235
0.69	1.449	0.9460	1.057	0.9276	1.078	0.9431	1.060	0.8259	1.210	0.7664	1.304	0.8164	0.224
0.70	1.429	0.9497	1.053	0.9324	1.072	0.9469	1.056	0.8322	1.201	0.7745	1.291	0.8230	1.215
0.71	1.408	0.9532	1.049	0.9369	1.067	0.9506	1.052	0.8385	1.192	0.7826	1.277	0.8296	1.205
0.72	1.389	0.9565	1.045	0.9414	1.062	0.9541	1.048	0.8447	1.183	0.7906	1.261	0.8361	1.196
0.73	1.370	0.9597	1.042	0.9456	1.057	0.9575	1.044	0.8509	1.175	0.7885	1.252	0.8426	1.186
0.74	1.357	0.9628	1.038	0.9497	1.053	0.9607	1.040	0.8570	1.166	0.8064	1.240	0.8490	1.177
0.75	1.333	0.9658	1.035	0.9536	1.048	0.9638	1.037	0.8631	1.158	0.8143	1.228	0.8553	1.169
0.76	1.316	0.9686	1.032	0.9573	1.044	0.9668	1.034	0.8691	1.150	0.8221	1.216	0.8616	1.161
0.77	1.299	0.9713	1.029	0.9609	1.040	0.9696	1.030	0.8750	1.142	0.8300	1.204	0.8679	1.152
0.78	1.282	0.9738	1.026	0.9643	1.036	0.9723	1.028	0.8809	1.135	0.8377	1.193	0.8741	1.144
0.79	1.266	0.9762	1.024	0.9675	1.033	0.9749	1.025	0.8868	1.127	0.8455	1.182	0.8803	1.136
0.80	1.25	0.9785	1.022	0.9706	1.030	0.9773	1.023	0.8926	1.120	0.8532	1.172	0.8864	1.128
0.81	1.235	0.9807	1.020	0.9736	1.027	0.9796	1.021	0.8983	1.113	0.8608	1.161	0.8925	1.120
0.82	1.22	0.9827	1.017	0.9763	1.024	0.9817	1.018	0.9041	1.106	0.8684	1.151	0.8985	1.113
0.83	1.205	0.9847	1.015	0.9789	1.021	0.9838	1.016	0.9097	1.099	0.8760	1.141	0.9045	1.105
0.84	1.19	0.9865	1.013	0.9814	1.019	0.9857	1.014	0.9154	1.092	0.8836	1.129	0.9104	1.098
0.85	1.176	0.9881	1.012	0.9837	1.016	0.9874	1.012	0.9209	1.085	0.8911	1.122	0.9162	1.091
0.86	1.163	0.9897	1.0104	0.9858	1.014	0.9891	1.010	0.9265	1.079	0.8986	1.112	0.9221	1.084
0.87	1.149	0.9912	1.0089	0.9878	1.012	0.9906	1.009	0.9320	1.072	0.9060	1.103	0.9279	1.077
0.88	1.136	0.9925	1.0075	0.9896	1.010	0.9920	1.008	0.9375	1.066	0.9134	1.094	0.9337	1.071
0.89	1.124	0.9937	1.0061	0.9913	1.0087	0.9933	1.0067	0.9429	1.060	0.9208	1.086	0.9394	1.063
0.90	1.111	0.9948	1.0052	0.9928	1.0072	0.9945	1.0055	0.9482	1.054	0.9282	1.077	0.9451	1.058
0.91	1.099	0.9958	1.0042	0.9942	1.0058	0.9956	1.0044	0.9536	1.048	0.9355	1.069	0.9508	1.051
0.92	1.087	0.9967	1.0033	0.9954	1.0046	0.9965	1.0035	0.9589	1.042	0.9428	1.060	0.9564	1.044
0.93	1.075	0.9975	1.0025	0.9965	1.0035	0.9973	1.0027	0.9642	1.037	0.9500	1.052	0.9620	1.039
0.94	1.064	0.9982	1.0018	0.9974	1.0026	0.9981	1.0019	0.9694	1.031	0.9572	1.044	0.9675	1.033
0.95	1.053	0.9987	1.0013	0.9982	1.0018	0.9987	1.0018	0.9746	1.026	0.9645	1.036	0.9730	1.0277
0.96	1.042	0.9992	1.0008	0.9989	1.0011	0.9991	1.0009	0.9797	1.0207	0.9716	1.029	0.9785	1.0219
0.97	1.031	0.9996	1.0004	0.9994	1.0006	0.9995	1.0005	0.9849	1.0155	0.9788	1.021	0.9840	1.0162
0.98	1.02	0.9998	1.0002	0.9997	1.0003	0.9998	1.0002	0.9899	1.0102	0.9859	1.014	0.9895	1.0106
0.99	1.01	0.9999	1.0001	0.9999	1.0001	0.9999	1.0001	0.9950	1.005	0.9929	1.007	0.9947	1.0053
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

COMPRESSION OR EXPANSION OF AIR.

the diagram, the given ratio of volumes is read upon the base line and the required ratio of the mean effective pressure is then indicated by the vertical height from the point thus indicated up to the curve representing the required data. It is assumed that no further explanation is required.

In computations relating to the power developed in the working expansion of air in a reciprocating engine or motor, the ratio of volumes is the particular most readily available, as that is determined by the point of cut-off, but in air compression we first know the ratio of pressures, and the ratio of volumes is derivable from this by the assistance of the previous table or diagram, so that both tables or diagrams are necessary to constitute a complete equipment, and they should be kept together. Of course only absolute pressures are dealt with, and when mean effective pressures are obtained, these also are absolute, and the actual working mean effective is obtained by deducting the pressure of the atmosphere. In compound compression or expansion, there must be subtracted the total absolute back pressure, which of course must be much greater than that of the atmosphere alone.



RATIOS OF MEAN EFFECTIVE PRESSURES IN ADIABATIC COMPRESSION

The several columns of the table designated by capital letters, and the corresponding lines of the diagram, represent the following ratios of mean to initial, or terminal, total pressures, the given ratio in each case being the ratio of volumes.

FOR ENTIRE STROKE.

H, Perfect gas, temperature constant.

J, Air expanding (or being compressed) without loss or gain of heat.

K, Saturated steam.

DURING EXPANSION OR COMPRESSION ONLY.

L, Perfect gas, temperature constant.

M, Air expanding (or being compressed) without loss or gain of heat.

N, Saturated steam.

The following are the formulas by which the computations were made, $\frac{1}{R}$ being the given ratio:

$$H \ldots\ldots \frac{1 + hyp.\ log.\ R}{R}$$

$$J \ldots \frac{3.451 - 2.451 + \left(\frac{1}{R}\right)^{0.408}}{R}$$

$$K \ldots 17 \times \frac{1}{R} - 16 \times \left(\frac{1}{R}\right)^{\frac{17}{16}}$$

$$L \ldots\ldots \frac{hyp.\ log.\ R}{R - 1}$$

$$M \ldots \frac{2.451 \times \left[1 - \left(\frac{1}{R}\right)^{0.408}\right]}{R - 1}$$

$$N \ldots\ldots \frac{16 \times \left[1 - \left(\frac{1}{R}\right)^{\frac{1}{16}}\right]}{R - 1}$$

Habits of computation vary with the individual, some paying more attention to minute points than others, and some doing mentally what would compel a liberal use of pencil and paper by others. In any case the detailed descriptions of arithmetical operations are apt to make them appear more complicated than they really are.

We will take here a very simple case of single-stage compression. Say that we have a straight-line compressor whose air cylinder is 24-inch diameter and 36-inch stroke, piston rod 4 inches, running at 72 revolutions per minute and compressing the air to 7 lb., gage; what will be the theoretic horsepower required for adiabatic compression? The area of a 24-inch circle is 452.39 square inches, and of a 4-inch is 12.56. Then (452.39 + 452.39 — 12.56) ÷ 2 = 446 square inches, as the mean piston area for both strokes.

As the compression is to 70 pounds, gage, the absolute pressure is 70 + 14.7 = 84.7, and the pressure ratio is 14.7 ÷ 84.7 = 0.1736. Referring to the table in the previous article to get the ratio of volumes (page 5428) using column *A*, we find that for 0.17, or 0.1700, it is 0.2841, and for 0.1800 it is 0.2959, the difference being 0.2959 — 0.2841 = 0.0118, then 0.0118 × 0.36 = 0.004248, and 0.2841 + 0.0042 = 0.2883 as the ratio of volumes.

Coming now to the table before us, using column *J*, we find that for 0.2800 volume ratio, the mean effective pressure ratio is 0.5580 and for 0.2900 it is 0.5718, the difference being 0.0138, then 0.0138 × 0.83 = 0.0114 and 0.5580 ÷ 0.0114 = 0.5694 as the mean effective pressure ratio.

It is usually not necessary, or, indeed worth while, to take all this pains to get the last two figures of the ratio, and in using the diagrams alone the operation would be much simpler. The pressure ratio, 0.1736, we would fix in our minds at 0.17⅓+, and finding this point on the base line of the previous diagram we would read the vertical distance up to curve *A* as 0.28⅞ —. Then turning to the diagram now before us, with 0.28⅞ — on the base line, we would read the vertical distance to curve *J* as 0.57, which would be sufficiently close to the 0.5694 obtained from the table.

The absolute terminal pressure of compression being 84.7, the absolute mean effective pressure is 84.7 × 0.5694 = 48.23, and the working mean effective is 48.23 — 14.7 = 33.5.

The theoretic horsepower then is: 446, mean piston area × 33.5 mean effective resistance × 6 ft. per double stroke × 72 revolutions per minute, ÷ 33,000 foot pounds = 196 horsepower, to which is to be added for friction whatever percentage information may warrant or judgment suggest.—*American Machinist.*

SOME AIR LIFT DATA

By G. A. Reichard.

Air lifts are used to quite an extent in this section, Los Angeles, Cal., for raising water and oil, in some cases operating in oil wells 2000 feet deep or more. In many cases the cost of installation is moderate and in all cases the cost of maintenance is very low, and air lifts, with compressors of any reasonable size, can be operated more economically than ordinary deep-well pumps. There are many situ tions where they are really the most economical appliances that can be used.

It is necessary, however, to have a proper amount of submergence to get economical operation. The exact amount of submergence for best work varies a little with the lift and quantity of water handled. Ordinarily, for lifts of 40 feet or less I would recommend about 2½ to 1, that is, 2½ times the amount of pipe below the surface of the water in the well when pumping the maximum quantity, to the lift above this level. With lifts of from 50 to 80 feet, 2 to 1 generally gives good results. On deeper lifts 1½ to 1 is frequently used. There are situations where sufficient submergence cannot possibly be obtained, and while the pumps may be operated with considerably less submergence, it generally increases the cost of pumping somewhat.

APPROXIMATE CUBIC FEET OF FREE AIR AND WORKING PRESSURE REQUIRED TO RAISE ONE GALLON OF WATER BY "AIR LIFT."

RATIO OF SUBMERGENCE TO LIFT.

	1 to 1.		1½ to 1.		2 to 1.		2½ to 1	
Lift in Feet.	Free Air. Cubic Feet.	Working Pressure, Pounds.	Free Air, Cubic Feet.	Working Pressure, Pounds.	Free Air, Cubic Feet.	Working Pressure, Pounds.	Free Air, Cubic Feet.	Working Pressure, Pounds.
20	0.428	9	0.31	13½	0.252	18	0.217	22½
30	0.47	13½	0.35	20	0.29	27	0.255	34
40	0.508	18	0.387	27	0.325	36	0.287	45
50	0.546	22½	0.422	34	0.36	45	0.32	56
60	0.582	27	0.457	40½	0.392	54	0.35	67½
80	0.653	36	0.522	54	0.455	72	0.41	90
100	0.72	45	0.585	67½	0.512	90	0.465	112½
120	0.785	54	0.642	81	0.567	108	0.52	135
140	0.847	63	0.697	94½	0.622	126	0.572	157½
160	0.907	72	0.755	108	0.675	144	0.624	180
130	0.965	81	0.81	121½	0.725	162	0.672	202
200	1.022	90	0.862	135	0.775	180	0.72	225

The quantity of air required depends somewhat on the size of the installation, the proper proportioning of the pipes, flow of water in the wells, etc., and it is impossible to give the exact quantity, as it is very seldom that two wells will work exactly alike.

I give herewith a table showing the approximate quantity of air required and working pressure for all ordinary cases. but know of a number of installations that are operated successfully with from 15 to 20 per cent. less air than is shown in this table, and a few installations that use more.

In selecting a compressor it is well to allow a surplus over the amount given in the table, as it cannot always be known before testing how much the water in the wells will fall when being pumped; and while some of the better makes of the larger sizes of compressors will give a volumetric efficiency of over 90 per cent., there are some of the smaller sizes of compressors, with poppet-inlet valves, that are deficient in inlet-valve area, and some of them will not deliver 60 per cent. of the amount of air that is shown by piston displacement when running at full speed. This, of course, varies with the inlet-valve area and speed.

The size of air pipe is not very important, providing it is large enough to carry the air without undue friction, and the working pressure given is based on there being very little friction.

The size of the pipe in which the water is lifted to the surface is, however, quite important, as there must be a fairly high velocity to work properly, and it is better to err in having the pipe a little too small than too large. The best work is generally obtained with a flow of from 12 to 18 gallons per minute per square inch of section. Smaller pipes will not stand quite so high a velocity as larger sizes.

The arrangement of the air nozzles at the bottom is not a matter of very great importance, provided, of course, the air pipe is somewhat above the bottom of the water pipe. There are a number of different arrangements that give good results.

In some cases, where it is desired to deliver the water at some distance away from and above the well, where sufficient submergence cannot be obtained, air-displacement pumps are used, that is, a cylinder or chamber is lowered into the well below the water line and provided with valves somewhat similar to pump cylinders, being alternatively filled and emptied with air under pressure. What is known as the "dense air" system, by which the air is returned to the compressor under considerable pressure, increases the economy of the compressor and makes a satisfactory and very economically operated pumping plant.

Direct-acting deep-well steam pumps are generally very wasteful in the use of steam and very seldom are any more economical to operate than a good air-lift system, properly installed. All kinds of deep-well pumps, having a long line of rods, generally, are quite expensive to maintain, to say nothing of the trouble and time lost in pulling and replacing rods and buckets. They are good things to keep away from wherever it is possible, particularly where any considerable quantity of water is required from deep wells. However, when operated at very slow speeds and large capacity is not required, their use is sometimes admissible.—*Power and the Engineer.*

PURIFYING WATER BY OZONE

Ozone is the best agent for purifying water, because it adds nothing except oxygen, which assists in aeration. An ozonizing plant has recently been installed at Saint Maur, near Paris, where the water of the Marne River was found to contain many disease germs, even after it had passed through sedimentation basins and sand filters. The ozone generators are of the Siemens type and are operated by a high-tension alternating circuit obtained by transforming the current of a 110-volt alternator, which is driven by a 44-horse-power steam engine. The total consumption of energy is 1 kilowatt hour for each 1,200 cubic feet of water, and more than half of the energy is employed in working the compressing pumps. The cost of sterilization is less than 5 cents per thousand cubic feet. The temperature of the water is lowered by the operation, and not a trace of nitrous oxide, chlorine compounds, hydrogen dioxide, or metallic salts due to corrosion of the apparatus can be detected in the sterilized water. Of the ozone absorbed, 73 per cent is consumed immediately in sterilization, 7 per cent. remains diffused through the water and exerts a subsequent sterilizing effect, and 20 per cent. escapes into the atmosphere.—*Scientific American.*

PNEUMATIC JAM RIVETER MECHANISMS

The operation of hot riveting in boiler making and bridge work requires a final squeeze of great intensity, and for this service the hydraulic riveter would seem to be specially adapted since its ordinary working pressures are 1000 to 1500 pounds per square inch and upward, which pressures are inpracticable for compressed air in such lines of work. The objections to the use of the hydraulic riveter, however, the weight of the machine, its unportability, its slowness in action, have suggested opportunities to inventors to supersede it, and now air at ordinary working pressures, not exceeding 100 pounds to the square inch, is ready to do any kind of work which has ever been done by the hydraulic riveter and without its objectionable accompaniments. Mr. W. T. Sears, in a recent issue of the *American Machinist,* discusses the devices which have secured the success of the pneumatic riveter.

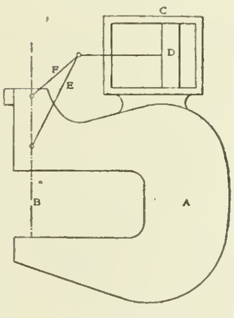


FIG. 1.

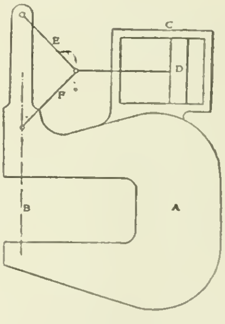


FIG. 2.

The most familiar designs of pneumatic riveters are the so called toggle machines. These are commonly of two types, Fig. 1 and Fig. 2. *A* is the riveter frame, *B* the center line of dies, *C* the cylinder, *D* the piston, *E* the toggle link connected to the frame, and *F* the toggle link connected to the plunger which carries the movable riveting die. In both of these machines, the toggles straighten out or, in other words, reach a point where the pressure exerted or leverage obtained theoretically runs up to infinity.

Such extreme pressures are of course not actually reached or even approximated, owing to the spring of the different parts, and of the riveter frame especially. This is shown graphically in Fig. 3, in which the curve *AA* represents the theoretical pressure curve exerted by a toggle at different points of piston travel, horizontal distance representing piston travel and vertical distance pressure exerted. Assuming the die first strikes the rivet at point *D,* then the pressure on the rivet would be somewhat along the curve *BB.* These curves are not actually figured, but are near enough for practical purposes of illustration.

The curve *BB* must of course keep below the curve *AA,* otherwise the riveter would stall. In actual practice this stalling often takes place say, at some place on curve *AA,* as at *Y,* when the riveter must be reversed, and the plunger length shortened by turning the screw die holder. At the next stroke the anvil will be struck later as at *E,* and the pressure curve will run up on some such line as *CC.*

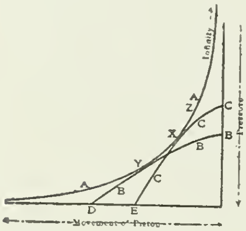


FIG. 3

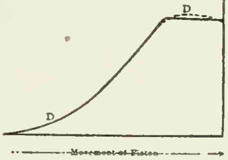


FIG. 4

If the die has been shortened sufficiently, the stroke will be completed and the critical point (in this case *X*) passed. From here on the pressure that can be exerted at the dies increases much faster than the resistance or, as shown in the diagram, the curve *AA* rapidly leaves *CC,* and the result is that the piston jumps with a quick movement to the end of its stroke, and the toggle hits its stop with a sharp rap. One of the chief losses in air is due in riveters of this class to the additional strokes taken, for unless there is the same amount of material in the rivet to be upset each time, and the riveted parts of almost exactly the same thickness, the die length must be adjusted often, and it is seldom or never adjusted correctly on the first stroke.

By repeating the strokes and adjusting the die length a little at each stroke, the point *X* can be carried higher and higher on the pressure line *AA* with the result, that the final riveting pressure, or *C′*, is somewhat increased over that obtained on the first stroke, or *B′*. This pressure is always indefinite, although by taking a number of strokes on each rivet the variation is much reduced, and the maximum approximated. Of course the curves *BB* and *CC* are not accurate; they vary with the size of the riveters, the length of the rivet, the thickness of material riveted, and the temperature of rivets themselves. The general action is, however, clearly shown, which is that the resistance at first is considerably less than the pressure which can be exerted; that these two quantities approach nearer and nearer (provided we assume the riveter is to exert its maximum pressure) until the variable critical point is reached. Beyond this point the pressure which the machine can exert rapidly increases over the resistance and the machine goes over with a bang, unless it is cushioned in some manner. The final pressure in most cases, is not much more than the pressure at the so-called critical point.

This indefiniteness of pressure is one of the main reasons for retarding a more general use of pneumatic riveters, and has prevented their superseding the hydraulic riveter to the great extent they undoubtedly would have done if this weakness had not existed.

While the action has been known and appreciated for many years, it is only comparatively lately that any good mechanical attempts have been made to modify the simple toggle riveter so that a known maximum riveting pressure can be exerted through some considerable distance. The problem has been attacked in several ways, the attempt being to approximate a curve similar to full line *DD,* Fig. 4, and up to date the writer is acquainted with three or four which give or approach this result more or less closely. In any event they come nearer to it than types shown in Figs. 1 and 2.

There are one or two others of such design that they are or could be so arranged as to give this ideal pressure curve, but owing to the manner in which the reduction of motion is obtained, the details of the parts that take thrust cannot be made so as to give satisfactory service at a reasonable cost of manufacture for pressures now demanded for riveting.

Fig. 5 shows one of these machines in which the pressure it is capable of exerting follows very closely along the line *DD* in Fig. 4.

The first action is somewhat similar to the toggle movement illustrated in Fig. 2, and the flattening of the curve at the end of the stroke is due to the movement of the link *G* around the end of link *E*. *F* is the compression link. It is connected to link *G* on one end, and to the plunger that carries the die on the other. *H* is simply the guide link for the system and forces it to move in the desired manner. If there is any serious criticism to be made of this toggle machine, it would probably be as regards the considerable number of levers or links which are used.

Fig. 6 shows a modification of Fig. 1. In this case the links *E* and *G* act as a single link until they reach approximately the position shown in the sketch. At this point, link *G* is stopped, and the links *E* and *F* complete the movement. As they are about the same length, the action while the lower end of link *F* is passing by the lower end of link *E*, gives a very nearly constant pressure for some little distance at the end of the stroke. This is considerably simpler than Fig. 5, and the pressure curve is practically the same; but the use of a jointed link in the manner shown, requires an additional spring or cylinder to control the movement of the link *G*.

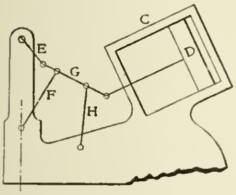


FIG. 5

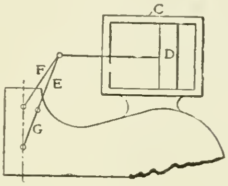


FIG. 6

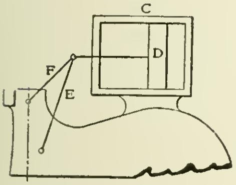


FIG. 7

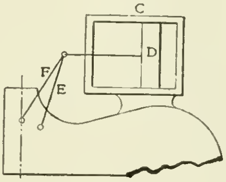


FIG. 8

Fig. 7 shows a modification which is but very little different from Fig. 1, except that the lower end of link *E* is moved back from the center line of the plunger that carries the die, with the result that the pressure curve does not rise at the end to quite the extent that it does on the type shown in Fig. 1. This curve, referred to before as *AA* in Fig. 3, is somewhat shortened, and the pressure would perhaps stop increasing at some point such as *Z*.

The general outline of the curve would not differ much from that given by Fig. 1. It is somewhat better, however, in that the surplus end pressure has been cut off, but if the stroke were to be continued until the center lines of links *E* and *F* coincide, the same conditions regarding infinity would occur. There is really no very appreciable flattening of the pressure curve at the end of the stroke, which is desirable.

Fig. 8 illustrates an arrangement of links which is very simple. There are no more parts than are used in Fig. 1 and 2, but the pressure curve closely approximates the line *DD* in Fig. 4, the variations being shown by the dotted line. In this device, the theoretical pressure can never reach infinity, for there is no possibility of the links *E* and *F* ever coming into the same line, unless moved through a half revolution, which is far beyond the limit of the stroke of machine. The actual curve follows very closely the one given by the machine shown in Fig. 6.

With a machine which is capable of giving a pressure curve approximately like *DD* in Fig. 4, the one uncertainty of the riveting pressure exerted by a pneumatic riveter disappears, and also the bother of continually adjusting the die length for slight variations in thickness, and other inequalities of the work.

It is simply necessary to be sure that the point of maximum pressure has been reached, and this can easily and surely be ascertained, by means of a signal such as the escape of air or by noting the position of some part of the link system. There is therefore no reason why such riveters should not take the place of, and satisfactorily perform the duty of any hydraulic riveter, especially for moderate pressure of, say, up to 75 or 80 tons, and that this is so is proved by the experience of such machines in many shops.

Compressed air in shops is coming to be more and more recognized as a necessity, and the list of operations on which a great saving can be made is increasing rapidly, and for this reason the above article was written. It calls attention to some points regarding riveting by air that are not generally recognized by shop men at large.

DETAILS OF THE BLASTING OPERATION

When the miner has completed the holes he is ready to blast. The powder used is sold in boxes which contain a certain number of sticks of powder of the shape and size of an ordinary candle, with both ends flat. There are usually thirty sticks in a ten-pound box, and as dynamite freezes at forty degrees temperature the sticks are more or less stiff. The powder is contained in strong, yellow paper, and the miner cuts it with his knife to give the stick a better chance to pack. The stick of powder is pushed into the hole and is packed carefully with a long wooden stick. The powder is introduced cut in several pieces, and the cap and the fuse are introduced with the last piece. The fuse is a cord of gutta-percha containing in its center a column of fine gunpowder.

The miner lights the fuse and goes to some place of safety. During this time the black powder burns inside the fuse, reaches the cap, explodes it and with it the giant powder, which is transformed into gases. The gases expand so as to occupy a space twenty thousand times greater than the one in which they are enclosed. They thus develop a pressure of more than thirty tons per square inch and force the solid rock to break into fragments to give them room to escape. The rocks are streaked by numerous slips, planes of fracture or lines of least resistance, along which the rock breaks in a few big chunks, or "breaks big," as the miners say; or it breaks into a thousand small pieces.

In every day practice a miner seldom drills and fires a single hole at a time. He drills in the breast or in the face of the workings several holes of various lengths and inclined at different angles. He disposes them in such an order and at such places that each explosion will work to the best advantage. The first hole not only will take a part of the block to be broken but it will loosen a side of the piece of rock to be blasted by the second hole, and help the powder in this hole to accomplish its work. The second hole will make easier in the same manner the work of the third one, and so on till the last one has exploded. The holes have to be fired in a carefully arranged order to give their maximum of results. With that end in view the miner cuts the fuses of different lengths, the second two inches longer than the first and the next two inches longer again, till the last, which is the longest of all. A practical hand can light the fuses so quickly that the difference of time in lighting them does not count.

The miner counts the explosions to make sure that all the holes have exploded. He knows then that he can safely pick the ground that he can pry and tear down, without danger, all the pieces of rock which have been shaken by the explosions but which are yet partially held by the solid rock.

In some cases, in the breast of a long and straight tunnel, for instance, the miner would have to walk too far before being out of danger. It has become the practice in such cases to fire all the holes at the same time from a distant and safe place by means of an electric battery.—*Mining Science.*

HAMMER DRILLS FOR SMALL SEWER WORK

The city of Bloomington, Ind., put off as long as possible the building of certain necessary sewers on account of the cost, as it involved much rock cutting. These sewers have now been built, and an account of the operations has been written for *Engineering News* by Mr. Geo. L. Thon. What follows is an abstract of Mr. Thon's paper.

Bloomington is located in the oolitic limestone region. This stone is the Bedford limestone which is quarried extensively in this locality for building purposes. The stone is found close to the surface of the ground, and in many cases outcrops in the surface of the street. Where it is covered with soil, the rock surface is generally very uneven, as was subsequently shown when the trenches were opened. Sometimes there would be a series of "hogbacks" extending across the trench, which were from 2 to 8 ft. wide outcropping or nearly outcropping on the surface, and between these "hogbacks" would be seams of clay extending sometimes even below the grade line of the sewer. The average depth of the sewers was about 6½ ft., except about 1,000 ft., which was laid in a cut or from 9 to 12 ft. The rock excavated from the trenches varied from a few inches to 12 ft. in depth.

The rock excavation being a large item in this contract, the necessity of an economical method of rock excavation was apparent. The contractor's attention was called to the use of hammer drills for this kind of work, and after obtaining one of these drills and testing its use on work of this kind, and being satisfied with the results obtained, installed two air compressor outfits with six hammer drills for each outfit. One of the air compressors installed was steam driven and the other was belt driven. The belt-driven machine was a 10x12-in. single stage air compressor, rated at 140 cu. ft. of free air per minute at 100 lbs. pressure when operated at a rate of 150 r.p.m. The other was a steam-driven single-stage 8x9x12-in. air compressor and rated at 124 cu. ft. of free air per minute at a pressure of 100 lbs. at 150 r.p.m. Both compressors were driven by a 16-HP. traction engine.

Each compressor outfit included about 1,000 ft. of 1½-in. wrought iron air pipe, 6 hammer rock drills with the necessary steel bits, 7-16-in. air hose, reheaters, valves, etc., with a small 7x9-ft. tool house. The tool house was mounted on a skid so that it could be pulled along the line of the work with the rest of the outfit by means of the traction engine. The belt-driven air compressor was also mounted on a skid, and the steam-driven compressor was mounted on a set of four heavy wagon wheels. The compressors were pulled along the line of the work as it progressed by the traction engines.

The cost of an outfit of this kind was as follows: The air compressors, each including an air drum, 1,000 ft. of 1½-in. pipe with valves, etc., cost about $800 each. The hammer drills cost $55 each. Fifty feet of 7-16-in. air hose for each drill cost $9, and the steel bits, which were of extra quality of steel, cost $2.50 each, for the three-foot lengths and proportionally more or less for the 2 and 4-ft. lengths. The total cost of each drilling outfit was about $1,300. The two traction engines that were used to drive the air compressors were rented at the rate of $5 per day from a local man. This included the cost of an engineer for each engine. The contractor furnished the fuel and oil.

These compressor outfits ran five drills successfully at a distance as high as 1,200 ft. from the air compressor, and by running the air compressor up to 110 lbs. pressure five drills could be operated at a distance of 1500 ft. from the compressor. On account of friction losses and leakage in the main pipe, 1500 ft. was about as far from the compressor as the drills could be economically operated.

The outfit was generally moved at intervals of about 1000 ft. along the line of the work, as it was easier to move the entire outfit than to operate with a longer air line. Moving the compressor outfit was a very simple matter. The pipe was unjointed and placed on a rack on the side of the tool house and then the air compressor and the tool house were chained to the rear of the traction engine and the whole outfit dragged to the next place where it was needed. In drilling close to the air compressor six drills could easily be supplied with sufficient air for drilling, but ordinarily only five drills were used, the extra drill being kept on hand for use in case any of the other drills had to be sent to the shop for repairs.

REHEATING.

During the winter when the temperature was below freezing, heaters were used to reheat the air just before it entered the drill. These heaters were placed in the air line between the main air pipe and the drill. The heaters were made of a ½-in. pipe 16 ft. long, which was bent in the form of a coil so that it could be inserted in the cylinder of an ordinary kerosene oil heater. The air supplying the drill passed through this coil of pipe, which was kept heated by the oil heater. In passing through this heated coil of pipe it became warm and materially increased the efficiency of the drill in cold weather.

Another form of heater used for the same purpose, and which proved even more satisfactory than the kerosene heater, was made by inserting a piece of 3-in. pipe 15 ins. long in the pipe supplying the drill. The 7-16-in. air supply pipe was enlarged by means of a bushing to the size of a 3-in. pipe, and then at the other end of the 3-in. pipe was reduced to the original size of the air supply pipe by the same means. This short enlarged section through which the air supplying the drill must pass at a decreased velocity is kept hot by means of a coal fire in a salamander. These methods of reheating the air proved fairly satisfactory and made it possible to work the drills on the coldest days during the winter.

The drills used are comparatively small, weighing about 20 lbs., and are easily handled by one man, a feature that led largely to their adoption in this work. The bits used in this work were of 2, 3 and 4-ft. lengths. When more than four feet of rock was excavated from the trench, 4-ft. holes were drilled and blasted and then the rock was redrilled. The bits are made of a hexogonal steel shank 1 in. in diameter, with a 5-16-in. hole running from end to end through the center of the bit. The cutting end of the bit is dressed to 1¼-in. gage and finished with a "rose" or eight winged cutting end. Part of the exhaust air from the drill is discharged through the hole that extends down through the bit to the bottom of hole being drilled, and in this way the hole is kept clean from dust. The drill when the bits are newly sharpened bores a hole 1¼ ins. in diameter, but as the bits wear the size of the hole drilled decreases. When the hole drilled becomes less than one inch in diameter the bits are resharpened.

But one man was required to operate a drill, and almost any ordinary laborer can learn to operate the drill in a few minutes and get good results. In fact, all the drillers on this work were selected from the laborers on the ditch and were men who had never seen a drill of this kind before. The men operating the drills were paid 17½ cts. an hour, which was but 2½ cts. an hour more than the wages paid for ordinary labor.

The cost of operating each drill outfit per day was approximately as follows:

Rent of traction engine, including engineer	$5 00
Five drillers, at 17.5 cts. per hour	8 75
Fuel and oil	3 00
Blacksmithing and new steel	1 00
Foreman	3 50
Water boy	50
Total cost per day	$21 75

With this outfit in a dry trench and fairly uniform rock, 5 drillers drilled 263 holes, each hole 3 ft. deep in a shift of 10 hours, or a total of 789 ft. of hole at a cost of 2.75 cts. per lin. ft. of hole drilled. This is probably about the average cost of drilling under reasonably favorable conditions in a dry trench. In a wet trench where the rock surface was covered with mud and water, the speed of drilling was somewhat retarded. In one case, however, in a trench where the majority of holes were drilled in rock covered with from 2 to 4 ins. of water, one man drilled 40 holes each 3½ ft. deep in seven hours, which is at a rate of 0.33 ft. of hole per minute. In another instance one man drilled 100 holes, each 18 ins. deep, in 10 hours, or at a rate of 0.25 ft. of hole drilled per minute, this being also in a wet trench.

The drillers experienced considerable difficulty in places, due to mud seams, which often underlaid the rock surface. When the bit struck a mud seam it would generally choke up the exhaust hole of the bit. When this happened, the hole drilled in the rock would not be cleaned from dust as it went down and difficulty was then encountered in getting the bit out of the hole when the drilling was finished. In some cases it was necessary to leave the bit in the hole until the rock was broken up by the blast from the adjacent holes.

The accompanying table shows the average rate of drilling holes by means of these drills as used in this work under actual working conditions:

RATE OF DRILLING 1¼-IN. HOLES IN OOLITIC LIMESTONE WITH HAMMER DRILLS. BLOOMINGTON SEWERAGE SYSTEM.

Depth of hole drilled, ins.	Time started.	Time stopped.	Total time per hole, mins.	Depth of hole drilled per minute, ft.
16	11.44 a. m.	11.47 a. m	3.	.45
20	11.44 a. m.	11.47 a. m.	3.	.55
18	11.48.5a. m	11.51 a. m.	2.5	.60
22	11.51.5a. m.	11.54 a. m.	2.5	.73
18	11.51 a. m.	11.54 a. m.	3.	.50
24	11.56 a. m.	12.00 a. m.	4.	.50
18	11.58 a. m.	12.00 a. m.	2.	.75
24	1.29 p. m.	1.31 p. m.	2.	1.00
24	1.24.5p. m.	1.27.5p. m.	3.	.66
24	1.28.5p. m.	1.32 p. m.	3.5	.57
3 consecutive holes each 4 ft. deep	1.30 p. m.	1.45 p. m.	15	.80

The table gives only the time occupied in drilling the hole, the time occupied in changing from one hole to another being included only in the last instance, where the time was taken for drilling three consecutive holes each four feet deep. While the table shows the rate at which holes can be drilled with these hammer drills, still for general information as to what can be accomplished with an outfit of this kind per day, the results given previously in this article would be a better indication as to what to expect from drills of this kind.

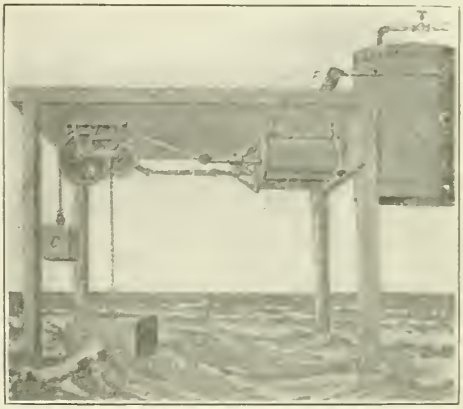
The distribution of holes put in the rock for the purpose of blasting varied with the nature and shape of the rock to be excavated. Where the rock was fairly uniform in depth and level on the surface, holes were placed on each side of the trench every 18 ins., measured along the ditch. A hole was placed in the center of the trench halfway between every alternate pair of side holes. Where there was less than one foot of rock to be excavated no side holes were drilled, the center holes alone being used to blast the rock. In some cases the center holes were omitted and the side holes were placed one foot apart. This arrangement of holes also gave good results in blasting. All holes were drilled 6 to 8 ins. below the grade of the sewer.

The holes were loaded with from 2 to 6 ounces of 60 per cent. dynamite. Four-ounce 7/8-in. sticks were used. This size stick of dynamite could easily be loaded in the holes drilled with the 1¼-in. drills. From 15 to 20 holes were loaded at once and connected into series with electric exploders and fired with a blasting machine. The blast broke the rock up so that it could be removed from the trench without further difficulty. The blasts were protected by laying a lattice made of 2-in. plank over that portion of the trench where the shot was to be fired, and a number of wooden poles were piled on the lattice, all of which was chained together with two log chains. Covering the blasts in this way proved a very effective way of protecting the blasts, and kept the broken rock from flying out of the trench.

The average cost of the rock excavation, including drilling, explosives, and removing the rock from the trench was $3.40 per cu. yd. In computing the rock yardage the trench was assumed to be 2-ft. wide.

THE SAND BLAST A LUXURY OF THE BATH

The very latest fad of the smart Parisienne is the sand bath, which she finds invigorating and beautifying. A few bushels of fine sea sand is brought to her room and slightly warmed before being spread out on a wide sheet. An energetic maid rubs her body all over with sand paper, turning her attention particularly to knees and elbows, which easily become roughened. After this process soft rich cream is massaged into the skin. Then the bather stands in the middle of the sheet and taking up handfuls of the sand she rubs it over her body till she is glowing with the friction. Then she reclines at full length on the sheet, the ends of which are folded over her, and rests several moments before rolling over and over so as to become completely immersed in the sand. Following this comes the hardest precess of the sand bath. It is called the blow bath and corresponds somewhat to the shower of a Turkish bath. From a sort of fan shaped blower sand is whirled out briskly so as to strike the body as forcibly as the bather can stand it. The effect is said to be wonderfully stimulating, and the sting is not unlike that produced by electricity. The sand brushes off the body easily and simply. The feeling of cleanliness and freshness following the bath is declared to excel the after effects of any water bath.



A COMPRESSED AIR WAVE MOTOR

The half tone here reproduced from the *Scientific American* will fully explain itself. Some poor fellow has "invented" another wave motor. The float is counterbalanced by the weight and rises and falls as acted upon by the waves. This rotates a shaft which is geared to a crank shaft and the cranks work the pistons in the compressing cylinders which deliver the compressed air to the receiver. The description of the apparatus informs us that "the cylinders are left open at one end, and no inlet valve is provided other than the piston washer."

AIR LIQEFACTION AND THE EXTRACTION OF OXYGEN

By Cecil Lightfoot.

The action of the Linde machine for air liquefaction is based on the refrigerating effect resulting from the expansion of air from a higher to a lower pressure, and which is due to the performance of internal work. At ordinary temperatures, this reduction in temperature amounts to about three-tenths degree

C. for each atmosphere of difference in pressure. It is, therefore, too insignificant to produce liquefaction of air at a single expansion, since this only takes place below —140 degrees C. (critical temperature of air) and at —191 degrees C. at atmospheric pressure, this being the boiling point of liquid air.

In the Linde machine the action of any desired number of expansions is accumulated and intensified by causing each preceding expansion to act as a fore-cooler to the air for the following expansion. This is attained by adopting the principle of heat interchange, which is, in this case, most efficiently applied by employing concentric tubes placed one inside the other and coiled in spiral form. The compressed air flows from top to bottom through the inner tube of the vertical double coil, expands through a valve between the inner and outer tubes from the bottom to the top, transmitting the cooling effect produced by expansion to the compressed air flowing down the inner tube. As a result the temperatures of the air before and after expansion are continuously reduced to the temperature of liquefaction, and part of the expanding air will collect in the liquid state in a vessel situated at the lower end of the heat-interchanger.

As the refrigerative action of the apparatus depends upon the difference of pressure before and after expansion, while the work of compression corresponds to the ratios of these pressures, the advantage of selecting a large difference in pressures, but a small ratio of pressures is apparent. In the machine herein described, the greater part of the cooling effect is produced by the expansion of air at an initial pressure of about 200 atmospheres to a pressure of 20 to 50 atmospheres, so that, according to the size of the machine, the difference of pressure is about 150 to 180 atmospheres, while the value of the ratio varies approximately from four to ten. Only the small quantity of air requisite for the primary charge and its subsequent renewal is introduced into the cycle from the surrounding atmosphere, leaving it again partly as liquid and partly as gas at atmospheric pressure.

The Linde machine for the liquefaction of air consists of the following parts: the heat-interchanger; the air-compressing plant; and appliances for the preliminary cooling and drying of the compressed air. The heat-interchanger consists of a triple coil composed of copper tubes placed one within the other. The cycle for air is performed, as already described, by causing air compressed to 200 atmospheres to flow downward through the innermost coil, at the lower extremity of which it is allowed to expand to an intermediate pressure of 20 to 50 atmospheres. The expanded air is then returned through the annular space between the innermost and middle coils to the top of the interchanger, when it is again compressed up to 200 atmospheres pressure and the cycle is repeated. By means of regulating valves, when the operation of the machine has been brought to a state of equilibrium, a small quantity of air is allowed to escape at atmospheric pressure, a corresponding amount being introduced into the cycle from the surrounding atmosphere. Part of this air leaves the second regulating valve in the liquid-air state and is collected in a vessel; the remaining portion is returned to the atmosphere through the annular space between the middle and outer coils. The liquid air is drawn from the collector by means of a small cock.

In the larger installations the necessary compression of the air is effected by means of a high-pressure air pump, which is usually arranged for two-stage compression, working in conjunction with a single-cylinder low-pressure air pump. The high-pressure cylinder of the former draws the partly expanded air from the heat-interchanger at an intermediate pressure of about 50 atmospheres, and compressing it up to about 200 atmospheres pressure, delivers it to the interchanger again, through a cooler. The air which is to be added to the cycle as "make-up" is supplied by a low-pressure air pump, which draws it from the atmosphere, compresses it to a pressure of about four atmospheres, and delivers it to the low-pressure cylinder of the high-pressure air pump, where it is compressed to a pressure of about 50 atmospheres. At this pressure it enters the high-pressure cylinder, together with the partly expanded air from the heat-interchanger. Regulation of the several pressures is performed with the aid of pressure gauges by means of the regulating valves in the heat-interchanger. Safety valves are provided to prevent the maximum pressures being exceeded.

The duty of air-liquefying plants is considerably augmented by a preliminary cooling of the compressed air prior to its entering the heat-interchanger. For this purpose a fore-cooler is provided, by means of which the compressed air is reduced in temperature to —12 or —15 degrees C. by filling the receptacle provided for the purpose with a suitable freezing mixture, such as ice and salt. With larger installations, the preliminary cooling is brought about by a small belt-driven refrigerating machine on the ammonia compression system. The adoption of fore-cooling is advisable in all cases, but especially when the cost of power is an item of great importance. Between the compressor and the fore-cooler, apparatus is provided for separating water from the compressed air. This apparatus is provided with a suitable drain cock. Further extraction of the aqueous vapors from the compressed air in the smaller installations is effected after the last stage of compression by means of chloride of calcium.

The principle of the Linde apparatus for the production of oxygen from the atmosphere consists first of all in the complete liquefaction of the air to be resolved. The liquid air thus obtained is then passed through an interchanger, in which it acquires the necessary latent heat of evaporation by assisting in the liquefaction of a further supply of air, and is then subjected to a process of rectification. This rectification, which is very similar to the process employed in spirit refineries for the separation of alcohol and water, enables oxygen having a purity of 95 per cent. to be delivered from the apparatus. If the output be reduced by 10 to 20 per cent., the quality of the oxygen produced may be brought up to as high a degree of purity as 98 or 99 per cent.

The interchange of heat which takes place in the apparatus is so complete that before the by-product nitrogen is returned to the atmosphere so much heat has been removed from the incoming air that it leaves the bottom of the fore-cooler at a temperature considerably below freezing point, and then enters the top of the separator, passing downward through a series of coils, which are so constructed as to be surrounded by both the outgoing cold gases, i. e., both oxygen and nitrogen. The bottom of the separator contains liquid air, or more correctly speaking, liquid oxygen. The compressed air, on its way to the expansion point, is conveyed through this liquid, by which means it is largely condensed. It then passes through a regulating valve, at which point it expands, and it is ultimately discharged into the top of an inner central chamber which forms the rectifying column in which the separation of oxygen and nitrogen is effected, oxygen descending in a liquid state to the bottom of the separator, and nitrogen ascending in a gaseous or vaporous condition to the top. The nitrogen is allowed to discharge freely into the atmosphere through an extension of the fore-cooler, and the oxygen is allowed to boil off in any desired quantity by the adjustment of an oxygen discharge-valve. Both gases, however, as already stated, on leaving the separator are kept in intimate contact with the coils conveying the incoming air, so that before leaving the apparatus the heat of the incoming air has been mostly transferred to the gases. It will thus be seen that after equilibrium has been attained, the process is practically automatic.—*Electric Journal.*

AIR LIFT EFFICIENCIES

By F. A. Halsey.

[The following, from the Journal of the American Society of Mechanical Engineers, is a contribution to the discussion of the paper, "Tests upon compressed air pumping systems of oil wells," by Edmund M. Ivens, presented at the Washington meeting of the society and printed, in an abridged form, in Compressed Air Magazine, May, 1909.]

The air-lift pump is one of those things of which our knowledge is almost exclusively experimental. Its analysis presents such serious difficulties that rational equations for the performance of the apparatus have not been derived by anyone to my knowledge. Under these circumstances, we are reduced to experiment for the determination of the fundamental laws of the performance of the apparatus, and these experiments should cover a wide range in the conditions which lead to variation in the performance of apparatus, namely, depth of submergence and lift.

The most complete experiments now on record were presented in a paper before the British Institution of Civil Engineers in 1906, these experiments being of sufficiently wide scope to supply a satisfactory guide for the design of these pumps under a considerable range of conditions.

One curious feature attends the behavior of the air-lift pump and the Taylor hydraulic air compressor, which are essentially the same apparatus, reversed in action. In each case we have a pair of vertical pipes communicating at the bottom, one filled with water and the other with a mixture of air and water—a sort of suds. If the pipes are of indefinite length the columns will take levels corresponding with their respective gravities, but if the suds pipe is cut off below this level it will overflow, the suds will rise, and we have an air-lift pump; while on the contrary, if the water pipe is cut off below this level, it will overflow, the column of water will rise, and we have a Taylor hydraulic air compressor. The point to which I refer is that while the first of these constructions has a low, the second has a high efficiency. The highest figure given in this paper for the efficiency of the pump is about 28 per cent., and while 40 per cent. has been reached in exceptional cases, the average is probably not more than 20 per cent. On the other hand, the efficiency of the hydraulic air compressor is in the vicinity of 75 or 80 per cent.

THE VENTILATION LAW FOR FACTORIES

The new law of the State of New York requiring a supply of fresh air for employes of workshops and factories reads as follows:

"The owner, agent or lessee of a factory shall provide, in each workroom thereof, proper and sufficient ventilation; if excessive heat is created, or if steam, gases, vapors, dust or other impurities that may be injurious to health be generated in the course of the manufacturing process carried on therein, the rooms must be ventilated in such a manner as to render them harmless, so far as practicable."

It must be obvious that a law so general in character, and so entirely lacking in specific requirements, should be supplemented by various data to secure intelligent and effective enforcement, and Mr. C. M. Ripley, in the September issue of *Machinery* does a good work in bringing together, as follows, various pertinent information relating to the subject.

Mr. William W. Walling, chief factory inspector for the State of New York, interprets the law as follows:

"As defined by Dr. John S. Billings, perfect ventilation means that any and every person in a room takes into his lungs, at each respiration, air of the same composition as that surrounding the building, no part of which has recently been in his own lungs or those of his neighbors, or which consists of the products of combustion generated in the building, while at the same time he feels no currents or drafts of air, and is perfectly comfortable as regards temperature, being neither too hot nor too cold. How much air is required to meet these conditions? Not less than 2,000 cubic feet per hour for each person, with the same amount per hour for each cubic foot of gas consumed, whether for light, heat or power."

IS THIS AMOUNT ARBITRARY?

Some landlords in New York City have put forth the claim that the amount of fresh air specified by the Department of Labor is an "arbitrary quantity." Several authorities on the subject of ventilation who have been consulted in the matter and who are also entirely disinterested agree that 2,000 cubic feet per hour per person is common practice and is based upon definite laws or rules which have been followed for many years in the design of ventilating systems.

The Architects' and Builders' Pocketbook, compiled by Mr. Frank E. Kidder, states that 1,800 cubic feet per hour per child should be the standard for school buildings, this amount being required by law both in Massachusetts and New York. It further states that in buildings more closely packed, and occupied for a longer period, the air supply should be from 2,000 to 2,500 cubic feet per hour per person. In giving an example of a school-room of certain dimensions, he shows that the standard amount of air would result in the air in the room being changed about eight times per hour, which certainly does not appear to be an excessive amount.

Since the above applies only to buildings where people sit quietly, or for buildings where only children congregate, it is difficult to see how the New York Department of Labor can justly be accused of an "arbitrary" action.

Mr. Percival Robert Foses, consulting, heating and ventilating engineer of New York City, states that he has found the rate of 2,000 cubic feet per hour per person a satisfactory and conservative working basis. This was used in designing the ventilating equipment of the large department store of B. Altman & Co., in the Rikers Island Penitentiary, in the Baltimore Stock Exchange, and in the new

Hearst Building at San Francisco, as well as in others; and he stated that the operating expense for a system laid out on this basis has not been found excessive.

EXAMPLE OF A LOFT BUILDING.

In a loft 25 feet wide and 100 feet long, containing 80 workmen, and lighted with electricity, the amount of air required would be 80 times 2,000 = 160,000 cubic feet per hour. This amount of air per hour would move at the rate of about ⅛ mile per hour, and would be sufficient to change the air in the loft six times per hour, assuming a ten-foot ceiling. Since the Massachusetts and New York State laws for school rooms require eight changes per hour, and since some authorities recommend even 50 per cent. in excess of this, it appears that the action of the factory inspector hardly comes within the definition of the word "arbitrary."

GAS LIGHTING.

Dr. Daniel R. Lucas, of New York City, states that it is a well-known law of hygiene that one gas jet will consume as much oxygen as five persons. Since electric lighting, thanks to the new high efficiency lamps, has been reduced in cost 50 per cent. or more, it appears that the easiest way to comply with the labor law regarding ventilation would be to abandon gas lighting.

Since the vitiating effect on the air of the average gas light is equivalent to that of five persons, it can be readily seen that the ventilation required will be reduced 5-6 by abandoning gas light, assuming one gas jet to each workman, or, stating it in another way, the landlord who clings to gas lighting must install ventilating apparatus six times as large as would be necessary if electric light were used. This calculation also is based upon conditions where one gas jet is provided for each workman.

OPERATING COSTS.

The operating cost for a ventilating system is made up of two items: (1) Power for turning fans; (2) Additional heat for incoming air. In a loft building where the tenant will pay for the power, and the landlord will pay for the extra heat required, since heat is included in the rent, the expense will be divided automatically. It will here be noticed that the adoption of electric lighting will cut down the operating expenses to a remarkable degree. This cut in expenses will benefit the tenant, since a much smaller ventilating motor will be required, and it will also benefit the landlord because less air will have to be drawn in, and hence the cost for heating will be diminished.

In large systems the services of an expert heating and ventilating engineer would probably prove valuable, and it is possible to so design the equipment that a judicious "recirculation" of the air from halls and basements will effect an economy in the fuel bill. This air is seldom impure and requires much less heat than if cold air were brought in from outside. It is also possible in buildings where high pressure steam is available, or where boilers which have been run at low pressure steam can be run at a high pressure, to adopt the following policy: Provide steam engines to operate the fans and turn the exhaust steam into the heating coils, thus getting a double use of the steam and cutting down the electricity bill. This idea could be carried still further in many instances, and economies could be made (especially in the winter) by abandoning electric pumping, and again reducing the expense for electricity. This is the stock argument of the advocates of isolated plants, who contend that great economies result in buildings of a million cubic feet or more, if engines are installed and electricity is made on the premises. It is a fact that steam at high pressure contains only about 6 per cent. more heat than steam at low pressure. Thus the argument that electricity can be made and a building heated with exhaust steam, is advanced. The layman does not appreciate one very peculiar fact about steam: that at 5 pounds pressure it is only about 6 per cent. cheaper to make than at 100 pound pressure.

In the future it is probable that factories and loft buildings will be equipped with ventilating apparatus at the outset, with the ducts concealed in the walls and the fans located in the basement. A model building of this character has recently been completed at 37-43 West 26th street, New York City, in which the landlord at the time of construction had the ventilating system installed at his expense, after the design of a prominent consulting engineer. Thus the cost of operating a system and the responsibility of maintaining it in good condition does not rest upon the tenant. At the present writing (June 17) we are informed that the owners of the West 26th street corporation have already rented eight out of the twelve floors, a flattering reception and appreciation of the advantages they have to offer.

IMPORTANCE OF PURE AIR IN THE INDUSTRIES.

In the report of the United States Bureau of Labor at Washington, D. C., it is shown that deaths among factory workers due to consumption were divided as follows:

Employes exposed to metallic dust	36.9 per cent.
Employes exposed to mineral dust	28.6 per cent.
Employes exposed to vegetable fiber dust	24.8 per cent.
Employes exposed to animal and fiber dust	32.1 per cent.

It was also shown that the highest consumption mortality existed among operators of grinders, and 49.2 per cent. of all deaths were from that disease.

An ingenious conclusion was reached by Mr. Frederick L. Hoffman of the Prudential Life Insurance Co., based on this report. It is his opinion that by intelligent methods of ventilation and dust removal the consumption death rate among the wage earners could be so reduced as to result in an annual saving of 22,238 lives. This would add, quoting the *Engineering News*, "15.4 years of life for every death from consumption avoided by rational conditions of industrial life." Such a gain would represent a total of 342,465 years of additional life, and by jüst so much the industrial efficiency of the American nation would be increased. Placing the economic value of a year's life time at only $200, the total average gain to the nation would be $3,080 for every avoidable death of a wage earner from consumption, representing the enormous total of $68,493,000 as the annual financial value clearly within the range of practical attainment. Therefore nothing within reason should be left undone as a national, state, individual, or social duty to prevent that needless but now enormous loss of human life from consumption due to the unfavorable conditions in American industry.

THE DESTRUCTION OF RATS WITH CARBON DISULPHIDE

M. de Kruyff, of the agricultural bureau of the Dutch Indies at Buitenzorg, Java, has published an interesting article on the destruction of rats. After working four years with numerous viruses without succeeding in creating an epidemic or even killing a single rat, De Kruyff obtained more encouraging results by employing carbon disulphide in the following manner: All visible ratholes were first stopped with earth for the purpose of ascertaining which holes were inhabited, for the inhabited holes were found reopened on the following day. Half a teaspoonful, or less, of carbon disulphide was poured into each of these holes and, after waiting a few seconds to allow the liquid to evaporate, the mixture of vapor and air was ignited. The result was a small explosion which filled the hole with poisonous gases and killed all the rats almost instantly. A pound of disulphide, costing about 10 cents, is sufficient for more than 200 ratholes; 131 dead rats were found in 43 holes which were opened after the operation. In two cases, 10 rats were found in a single hole.

GRAPHITE FOR AIR COMPRESSORS

Graphite prints the following from a correspondent:

It has been a long time since I wrote you about graphite (seven years, I think), but I have been using it daily all these years nevertheless. I have had charge of an air compressor for lifting water by the air lift system, for the Gulf, Colorado and Sante Fe R. R. at this place, for the past ten years, and in all that time I have used a mixture of valve oil and graphite in the air cylinder, and to-day, after ten years use, the air cylinder is in as good condition as the first day it was started ten years ago. The air cylinder has never been rebored in all that time, and the rings in piston are perfectly tight. I have used graphite and oil on other parts of the engine during the past ten years, and the engine is in good condition at the present writing, never being overhauled in that time. I occasionally allow the machine to "inhale" a little dry graphite through the inlet valves.

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FRANK RICHARDS, - - Managing Editor
L. I. WIGHTMAN, - - - Business Manager
H. L. KEELY, - - - - Circulation Manager

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THE INTAKE PRESSURE IN AIR COMPRESSOR CYLINDERS

The types have an inveterate spite against us, and all too frequently they succeed in making an absurdity of what we intended for an intelligible sentence. In the issue immediately preceding this, on page 5442, eleventh line from the top, "this *use* of temperature" should of course have been "this *rise* of temperature."

The article in which this substitution was perpetrated bore the same title as above, and touched upon the possible cause of the high and theoretically impossible intake pressure often noticed in the indicator cards of air compressor cylinders at the precise moment when the intake ceases and compressian is about to commence. It occurs to us that an additional suggestion as to the explanation of this phenomenon may be found in a concrete example from actual practice.

Say that we have a compressor with air cylinder 24 in. diameter by 36 in. stroke running at 60 revolutions per minute, giving the piston a travel of 360 feet per minute. The action of the crank will make the actual piston speed at the middle of the stroke 565 feet per minute, and this speed comes down to nothing at the end of the stroke. That is, the speed of the body of air which follows the piston on its intake side rises from nothing to 565 feet per minute in one quarter of a revolution of the crank or in one quarter of a second, and then the air movement comes down to nothing in the next quarter of a second, and so on continually. If the air comes through a pipe from outside the compressor room, its diameter being one third that of the cylinder or one ninth of the area, then for the air in the pipe, to follow the piston at its highest speed it must travel 565 x 9 = 5085 feet, or very nearly a mile a minute, and every quarter of a second the inrushing column of air must change its speed from zero to this mile a minute, or vice versa. Air has weight and inertia and it requires power to move it, and greater power to move it at accelerating speeds. The air enters the cylinder, following the piston, on account of the difference of air pressure between the normal atmospheric pressure outside the cylinder and a somewhat lower pressure within the cylinder, this lower than atmospheric pressure in the cylinder during intake being correctly reported by the indicator card. As a certain difference of pressure between the outer and the inner ends of the intake column is absolutely required to start and to accelerate its movement, so also the retardation and stoppage of the inrush cannot occur without a reversal of the difference of pressures, the difference in this case being due to an excess of pressure within the cylinder above the normal pressure outside, and when the indicator card makes its report of this excess of pressure we may accept it not only as correct but also as adequately accounted for.

VALUE OF THE AFTERCOOLER

By Howard H. Bliss.

While reading Frank Richards' article on "Air Receiver Practice," in a recent number, [Compressed Air Magazine, Oct., 1909, page 5419], I became curious to know what proportion of the moisture contained in compressed air could be got rid of by the expedient of cooling the air thoroughly and allowing plenty of time for the mist to settle and be drained off. To investigate this I assumed the following problem:

Taking saturated air at 72 degrees Fahrenheit, compressing it to 150 pounds per square inch absolute, cooling it in an aftercooler to 72 degrees and allowing it to stand until no free moisture remains suspended, how much water is removed per pound of air? If the entire water content of the air were carried through the system and the air used in a drill taking 100 cubic feet of free air per minute, how much more water would be released to clog the exhaust than if the drill were run with air dried as in the first case?

According to Kent (page 484, edition of 1898), one pound of free saturated air contains 0.0168 pound of water at 72 degrees. When this pound of air is compressed to ten times the original pressure and the temperature is brought back to 72 degrees, the volume of the air, by Boyle's law, will be one-tenth of the original volume. The weight of water which can exist as vapor in one cubic foot of air is independent of the pressure of the air and depends only upon the temperature; therefore there can be now only one-tenth as much vapor in our pound of air as there was at first—nine-tenths of the 0.0168 pound will have become mist. Hence, the answer to the first question is, nine-tenths of 0.0168 or 0.0151 pound. The water remaining as vapor is 0.0017 pound.

To get an answer to the second question an assumption must be made as to the temperature of the exhaust. It may be taken at 0 degree Fahrenheit. Then, by Kent's table, the vapor in one pound of exhaust air amounts to 0.0009 pound. All the rest of the water present will be frozen as it passes out. So in the case where the compressed air is cooled and the water drained off the ice in the exhaust would weigh

$$0.0017 - 0.0009 = 0.0008$$

pound for each pound of air. When none of the moisture is removed from the compressed air the ice in the exhaust will weigh

$$0.0168 - 0.0009 = 0.0159$$

pound per pound of air.

Each cubic foot of free air at 72 degrees weighs 0.0747 pound, so that the drill using 100 cubic feet per minute takes

$$100 \times 0.0747 = 7.47$$

pounds per minute. The ice formed in the exhaust each minute would be

$$7.47 \times 0.0008 = 0.006$$

pound for the dried-out air, and

$$7.47 \times 0.0159 = 0.119$$

pound for the undried air. Hence, the process of aftercooling and allowing the water to settle out saves

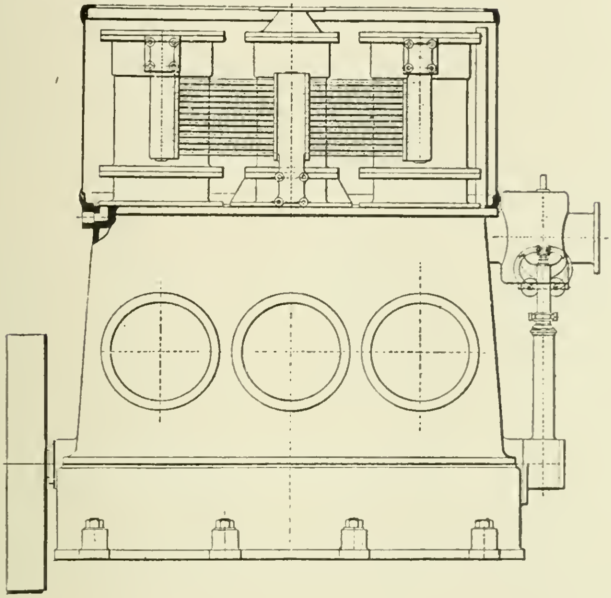
$$0.119 - 0.006 = 0.113$$

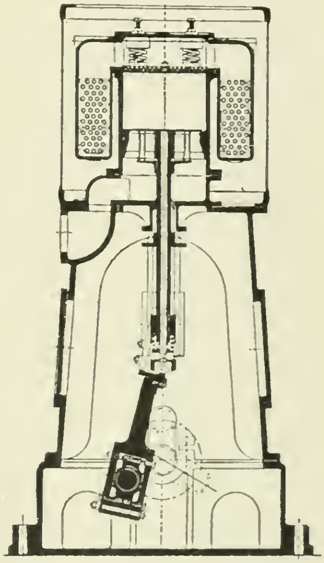
pound of ice in the exhaust every minute. The proportion of ice in the two cases is 0.006 to 0.119, or 1 to 19.8.—*Power and the Engineer.*

FLIGHTS OF THE WRIGHTS

On October 2, in a flight by Orville Wright at Potsdam, Germany, a height of 1,600 feet was reached. The height was estimated only with a rough approximation by noting the time required for the ascent, 15 minutes, the descent being made in 5 minutes. A pocket aneroid would have indicated the height attained very satisfactorily.

On October 4th Wilbur Wright made a notable flight from Governor's Island up the Hudson River, passing over the anchored warship of England, France, Germany, Italy, and the United States, assembled for the Hudson-Fulton celebration, passing around the tomb of General Grant and landing neatly at Governor's Island again. The distance traversed was about 20 miles and the time of flight was 33 minutes. As the aeroplane passed our window, which is about 200 feet from the ground it just covered the top of a chimney of a somewhat greater height on the other side of the river.





THE SCOTT AIR COMPRESSOR

The cut herewith, reproduced from *The Engineer*, London, gives the essential particulars of an air compressor embodying several novel and interesting features as recently exhibited at the Gloucester show of the Royal Agricultural Society. It is a power driven machine with three vertical single acting cylinders, two for low pressure and the middle one for the high pressure. The water jacket which encloses all the cylinders is traversed by a series of tubes which serve as an efficient inter-cooler between the compression stages. The discharge valves consist of a considerable number of steel balls, such as are used for ball bearings, and each ball has a seat of its own in a steel plate, the lift being controlled by a guard plate the holes in which are pitched in between those on the lower plates. A large valve opening is secured while the balls lift only a sixteenth of an inch or so, while springs and other complications are avoided. The air is admitted to the cylinders through valves in the top of the piston. These valves are made of thin steel plates and they are operated by a rod which passes through the center of the piston rod. The lower end of this rod is fitted with a guide and roller and a spring for closing. The roller is moved by an adjustable hardened steel cam placed in the jaw of the connecting rod. As this connecting rod swings across the top center at the time when its horizontal movement is greatest and its vertical movement negligible, the cam causes the intake valves to open so rapidly that they are wide open before one-quarter of the stroke is made and are shut again when the piston reaches its lowest point of travel. The steel delivery valve plates form the top covers of the cylinders, and are held down by strong steel springs, which normally do not act when the compressor is running, but are provided to act as buffers in case the piston touches the cover.

One of the obstacles to mining on the coast of Africa is the malaria-carrying mosquito. Gold mining there depends for its success on the extermination of this pest by draining the lands and other sanitary measures.

PNEUMATIC ELECTRIC SEA SOUNDING

The sounding apparatus which until recently has been in use in the German navy consists of a glass tube closed at the top, silvered on the inside and attached vertically to a heavy sounding lead. When the tube descends the water rises within it, compressing the air according to the depth and at the same time dissolving off the silver, thereby registering the maximum depth. The operation is extremely simple, the objection being that for each record the tube must be drawn to the surface to have the silvering renewed.

For this is now being substituted an electric device in which the air tube is connected to a cylindrical member containing mercury and so arranged that the increasing air pressure causes the mercury to rise and submerge a pair of high resistance wires, the resistance varying according to the height of the mercury. The resistances can be read on board the vessel by means of wires which run down to the tube, giving constant indication of the varying depths.

A SCHOOL OF AERONAUTICS

A higher school of aeronautics has been established in France. The new school, which is due to the conception and efforts of Commandant Roche, will be concerned with the practical side of aeronautics and aviation, and the pupils who succeed in passing its examinations will receive the title of aeronautical engineer. The course will last a year, and the lectures will be devoted to all the principal branches of aeronautics and aviation, including motors, while additional lectures will be given on subjects concerned with the progress and evolution of aerial navigation.

COMPRESSED AIR IN THE COAL MINE

The advantages of compressed air at the coal face over every other form of motive power, in fiery, dusty or hot mines, cannot be overestimated, absolute safety being assured in the most dangerous and gassy mine. The escaping air clears out the dust, assists in ventilation, and also cools the air in the workings; the importance of this last will be appreciated by those who have spent any time in a hot mine.

THE MOTOR-DRIVEN COMPRESSOR

The steam-driven compressor has still a useful field before it for colliery work, as under certain conditions it may prove the best, if not the most economical, unit, but it is in the motor-driven compressor that we most nearly approach the ideal power for driving auxiliary machines at the coal face in a dangerous mine. Such compressors may be placed out of the way, but as near to the coal face as safety will permit, the advantages of this arrangement being a flexibility of power almost equal to electricity, a higher factor of safety, and a multiplicity of small motors done away with.—*Iron and Coal Trades Review.*

Size of Tires		Maximum lbs. Weight per Tire	Actual Weight per Tire	Lbs. Inflation-Pressure Required
Metric	American			
	30 x 3	500	300 lbs. to 400 lbs.	50
	28 x 3		400 lbs. to 500 lbs.	60
710 x 90	28 x 3½	700	400 lbs. to 600 lbs.	60
760 x 90	30 x 3½			
810 x 90				
840 x 90	32 x 3½	800	600 lbs. to 700 lbs.	70
870 x 90	34 x 3½		700 lbs. to 800 lbs.	75
910 x 90	36 x 3½			
765 x 105	30 x 4	850	650 lbs. to 800 lbs.	60
815 x 105	32 x 4	1,000	800 lbs. to 950 lbs.	70
875 x 105	34 x 4	1,100	950 lbs. to 1,100 lbs.	75
915 x 105	36 x 4			
820 x 120	32 x 4½	1,100	700 lbs. to 900 lbs.	60
			900 lbs. to 1,100 lbs.	70
880 x 120	34 x 4½	1,300	1,100 lbs. to 1,300 lbs.	80
920 x 120	36 x 4½			
895 x 135	34 x 5	1,400	1,000 lbs. to 1,300 lbs.	70
936 x 136	36 x 5	1,600	1,300 lbs. to 1,600 lbs.	80

AIR PRESSURES FOR PNEUMATIC TIRES

The proper and sustained inflation of the tires of automobiles is a detail of operation which is of the greatest inportance. It not only minimizes the vibration of the machine and adds to the comfort of the riders but it is necessary for the preservation of the tire. If the tire is not inflated with a sufficient pressure, so that it stand up full and round under its load, then as it travels along the material of it is subject to abnormal bending, and, on account of the thickness, this bending upon itself constantly reversed makes internal friction and chafing, and the tire is soon actually worn out by its own internal friction.

The manufacturers of tires have done an important service—both for themselves and their customers—in publishing tables of tire sizes and air pressures, and these it is quite necessary to approximately follow if satisfactory results are desired. The figures given by the different makers vary, as might be expected, but the following by the Michelin Tire Company seems to represent good average practice.

TUNNELING

As the United States continues to grow in wealth and importance, tunneling operations increase in like proportion, both in number and in magnitude. New York city and its environs are now underlaid by a network of tunnels, and other cities are rapidly developing underground systems, since through the increase in population business and travel become congested. All over the United States water supply, hydro-electric power, and the reduction of grades on railways are requiring new and expensive tunnels, to which, in the West, are added the great irrigation tunnels called for in both Government and private enterprises. The result of all this activity in tunneling has been a vast improvement in both machinery and methods, and a greatly increased number of thoroughly trained and skilled workmen, so that records formerly unattainable in the United States are now being made in widely separated localities.—*Presidential Address, Spokane Meeting Am. Inst. Mining Engineers.*

MEASURING THE AIR

As the use of compressed air increases it becomes more and more necessary to be able to measure the actual volumes of air which are compressed and delivered by different machines, so that their volumetric efficiencies and actual economies may be accurately determined, and also in the use of the air by different apparatus or in specific operations it is equally desirable to know the volumes of air employed. As to compressor efficiencies the filling of tanks of known capacity may do for laboratory investigations of small compressors, but the method cannot be considered practical and is of limited application at the best.

What is wanted is an apparatus which can be connected to compressed air piping wherever desired and which will give a continuous and permanent record of air passing through at whatever pressure, reporting the same, for uniformity and convenience, in volumes of free air. This is claimed and guaranteed to be done by the St. John Indicating and Recording Air Meter advertised in this issue. It is applicable to air, gas or steam; it records continuously the cubic feet of free air or gas used during each hour of the day, and a permanent record is made by it for the hour, day or month, so that where it is used the actual air consumption and the cost of it may be known.

A LIFE SAVING CANNON

Wrecked vessels are usually unprovided with any means of throwing a life line to shore, but the new apparatus brought before a British committee of experts by A. J. McLeod, of West Hartlepool, is designed especially for use from the ship. It is a cannon, with a barrel five feet long mounted on a four-wheeled carriage. Compressed air is the propelling power and a crank wheel on each side gives a means of quickly generating by hand sufficient energy to throw the line carrying projectile half a mile. A special check keeps the line from unwinding from its winch so rapidly as to become tangled. In the trials made this apparatus seems to have proved more efficient and to have a longer range than the ordinary rocket, and, as it uses no explosive, it can be employed without risk of firing any combustible or explosive cargo. Line firing from the vessel has a number of advantages. The apparatus is promptly at hand, the wind is usually toward shore and the land is a much better target than the life savers have when working from shore.

IRRIGATION TRANSFORMATION

Within the confines of that vast region which our early geographers marked as the Great American Desert, and which Webster and Clay described as an uninhabitable and worthless waste, probably 13,000,000 acres have been reclaimed by irrigation, and homes for half a million families have been provided on farms. Irrigation canals representing an investment of $150,000,000, and long enough to girdle the globe with triple bands, have spread oases of green in sixteen arid states and territories. An annual harvest valued at not less than $250,000,000 is the desert's response to the intelligent application of water to her sunburned valleys. Practically all of this stupendous miracle has been wrought within the past quarter of a century, and a large part of it by individual enterprise. The Great American Desert no longer calls up a vision of desolation and horror. With the westward march of settlers its boundaries have shrunken. Railroads have thrust its barriers aside. Its flowing streams, and its underground waters are being measured and studied and we are beginning to grasp faintly a little of its potential greatness. Conservative engineers, on the basis of our present knowledge, estimate that not less than 30,000,000 acres are yet reclaimable by water from the streams which drain it.—*Farm Implements.*

LATEST U. S. PATENTS

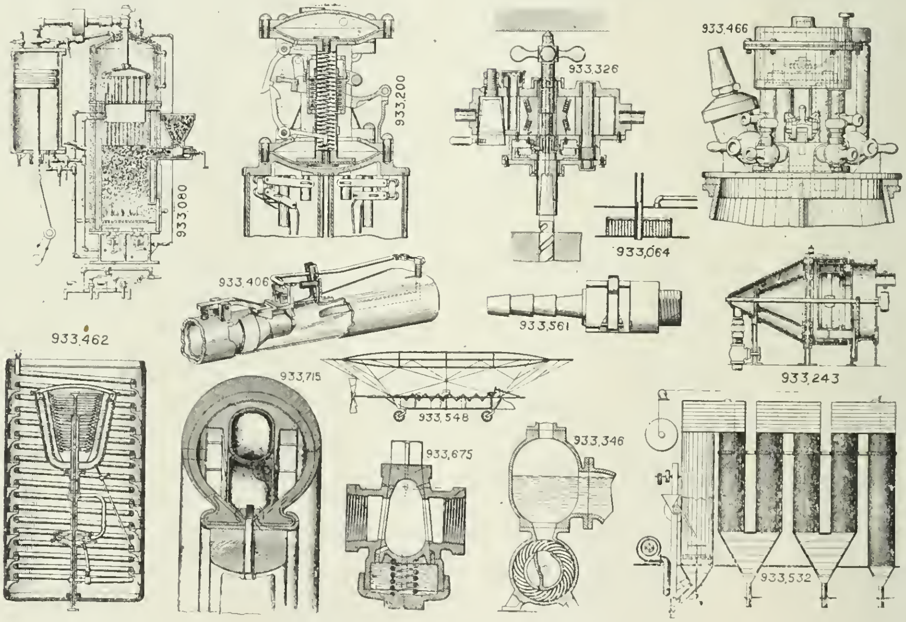
Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

SEPTEMBER 7.

933,064. CARBURETED-AIR APPARATUS. Edward B. Dennie, Newport News, Va.
933,080. HEAT-ENGINE PLANT. Simon Lake, Bridgeport, Conn.
933,200. PNEUMATIC PUMP OR APPARATUS FOR RAISING WATER BY MEANS OF COMPRESSED AIR. Thomas O. Perry, Chicago, Ill.
933,243. APPARATUS FOR SEPARATING MIXED GASES. Charles J. A. Fiesse, Washington, D. C.
933,527. PNEUMATIC-DESPATCH APPARATUS. William A. Brown, Chicago, Ill.
933,532. APPARATUS FOR GRADING PULVERULENT MATERIALS. Simon Cooper, New York, N. Y.
933,548. AEROMOTOR. Samuel H. Gilson, Salt Lake City, Utah.
933,551. PNEUMATIC HEEL-CUSHION. William L. Gordon, Deal, N. J.
933,561. PNEUMATIC TOOL-COUPLING. Alexandre Herbert, Montpelier, Vt.
933,675. SELF-LUBRICATING AIR-COCK FOR ROCK-DRILLS. Carl Senn, Stocking, Cal.
933,715. PNEUMATIC TIRE FOR AUTOMOBILES AND OTHER VEHICLES. Charles A. Lewis, Denver, Colo.

SEPTEMBER 14.

933,751. METHOD FOR MAKING SOUND METAL INGOTS AND OTHER CASTINGS. Robert A. Hadfield, Sheffield, England.
933,793. ACETYLENE-GAS APPARATUS. Coleman K. Sober, Lewisburg, Pa.
933,926. CLEANING APPARATUS. Fred J. Seeley, Pontiac, Mich.
933,972. TRACK-SANDER FOR LOCOMOTIVES. James E. Ganson, Columbus, Ohio.
933,991. PNEUMATIC SANDER. Charles F. Kabisius, Salt Lake City, Utah.
934,019. FLUID-PRESSURE BRAKE SYSTEM. William H. Sauvage, New York, N. Y.



Pneumatic Patents September 7.

933,326. PNEUMATIC DRILL. Martin McCune and Josef F. Meloun, Cleveland, Ohio.
933,346. AIR AND GAS PUMP OR COMPRESSOR AND THE LIKE. Walter Scheurmann, Newark-on-Trent, England.
933,366. DOUBLE-SCALE PNEUMATIC MUSICAL INSTRUMENT. Thomas Danquard, New York, N. Y.
933,406. PNEUMATIC-TUBE SWITCH. Edward W. Wallace, Detroit, Mich.
933,462. APPARATUS FOR SEPARATING OXYGEN FROM AIR. Joseph E. Johnson, Jr., Long Dale, Va.
933,466. MILKING-MACHINE. Robert Kennedy, Glasgow, Scotland.
934,096. PNEUMATIC TOOL. Andrew Schum, Mariah Hill, Ind.
934,107. METER. Albert H. Taylor, Easton, Pa.
934,138. FLUID-PRESSURE SWITCHING DEVICE. Robert V. Cheatham, St. Mathews, Ky.
934,293. SUPPLEMENTAL AIR-BRAKE MECHANISM. Arthur Doan, Oakland, Cal.
934,323. GOVERNOR FOR AIR-COMPRESSORS. John H. Kloer and Dorsey B. Leavell, Los Angeles, Cal.
934,418. CARRIAGE FOR PORTABLE PNEUMATIC DRILLS OR OTHER APPARATUS. Richard H. Robinson, New York, N. Y.

SEPTEMBER 21.

934,454. MACHINE FOR BOTTLING AND SYRUPING AERATED BEVERAGES. Alfred E. Munson, Chicago, Ill.

934,504. METER FOR LIQUIDS AND GASES. Frederick N. Connet, Providence, R. I.

934,514. BLOWPIPE. Cornelius D. Fitzsimmons, Philadelphia, Pa.

934,591. POISON-DISTRIBUTER. Henry E. Brandt, Chisago City, Minn.

934,628. PNEUMATIC JET FOR CONVEYERS. Earley W. Rice, Waxahachie, Tex.

934,640. PNEUMATIC TOOL. Wilber H. Van Sickel, Philadelphia, Pa.

934,647. CISTERN. Olin M. Alexander, Anniston, Ala.

1. In a cistern, a body, a pressure tank in the body, a valve establishing communication between said tank and body and arranged to close upon the establishment of pressure in the tank, a water-conducting pipe leading from the tank, a local air-compressor, a non-ventilating pipe independent of and at all times out of communication with the water-conducting pipe and establishing direct communication between said local air compressor and the tank, and a draw-off faucet interposed in the water-conducting pipe, said faucet affording means for venting said pressure tank.

934,650. WINDMILL. Alva Ayers, Barberton, Ohio.

934,689. WINDMILL-GOVERNOR. Louis M. Nelson, Douglas, Wyo.

934,728. TRACK-LAYING APPARATUS. Henry W. Jacobs, Topeka, Kans.

5. In an apparatus for constructing railroad track, the combination of a car having a motor thereon, a car having an air compressor thereon, an air reservoir also mounted on said last-mentioned car, track working tools adapted to be operated by compressed air, and connections between said reservoir and said tools.

934,785. COMPRESSED-AIR SIGNAL. Robert Armstrong, Victoria, British Columbia, Canada.

934,838. APPARATUS FOR RAISING SUBMERGED SHIPS AND OTHER BODIES. Benjamin Reinier, Vidauban, France.

5. A caisson for refloating sunken ships and similar purposes having a double wall forming a hollow jacket which can be filled with water

a removable cover and being available for carrying goods.

934,879. PIPE-LINE SYSTEM FOR BREWERIES AND BOTTLING ESTABLISHMENTS. Charles L. Bastian, Chicago, Ill.

1. In a pipe line system for breweries and bottling establishments, the combination of a beer supply vat, a pipe connected to the vat at the bottom thereof and delivering beer to the head of a filling or racking machine, a pipe discharging into the vat at the top thereof for supplying air pressure upon the beer in the vat, and means controlled by the pressure of the beer outside the vat for automatically increasing the air pressure in the vat without disturbing the beer to compensate for the loss of pressure as the level of the beer is lowered during the filling operation and thereby provide for constantly delivering the beer to the head at a predetermined presssure without loss of gas.

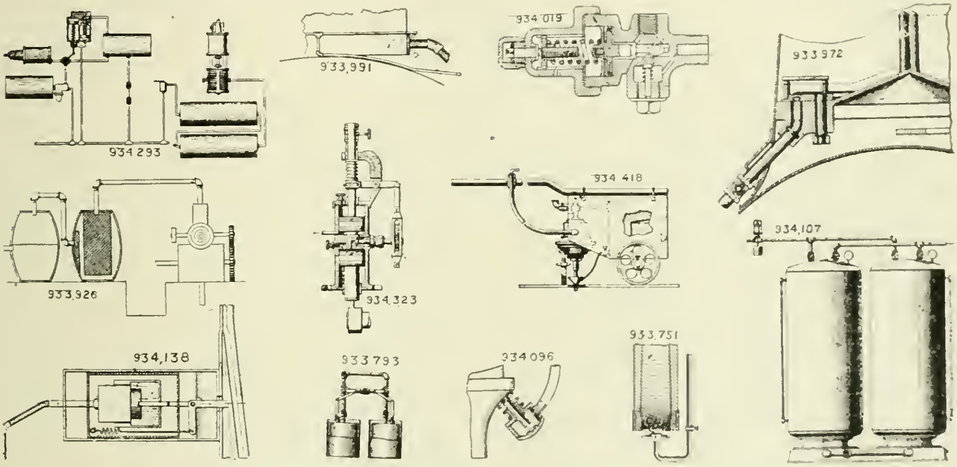
934,953. LUBRICATOR. George E. Witt, San Francisco, Cal.

1. The combination with an air compressor, and a discharge pipe thereof, of a receiver with which the discharge pipe is connected, a check valve between the receiver and compressor, an

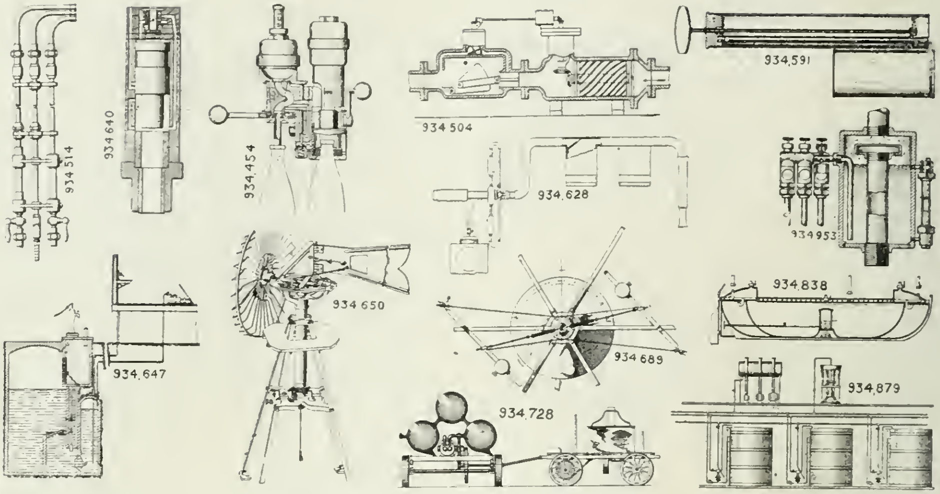
for submerging the caisson, and into which air may be forced for raising it, the center having oil reservoir interposed in the discharge pipe between the check valve and the compressor, said discharge pipe opening into the reservoir whereby the oil contained therein is subject to the pressure of the air, and feed pipe connection between the reservoir and the part to be lubricated.

934,956. METHOD OF DELIVERING LIQUID. Charles L. Bastian, Chicago, Ill.

1. The method herein described of delivering beer from a supply vat to the head of a filling or racking machine at a constant pressure and with evenness of flow during the filling operation to avoid agitation and foaming, which method consists in providing an initial air pressure above the beer in the vat which, together with the weight of the beer, is sufficient to deliver the beer from the bottom of the vat at a predetermined pressure to the head, and then increasing the air pressure above the beer in the vat relatively to the lowering of the level of the beer by the pressure of the beer outside of the vat and without disturbing the beer to compensate for the loss of pressure due to the withdrawal of beer from the vat, whereby to deliver all the beer in the vat to the head of the filling or racking machine at the same pressure and without the loss of gas.



Pneumatic Patents September 14.



PNEUMATIC PATENTS SEPTEMBER 21.

SEPTEMBER 28.

935,039. FLYING-MACHINE. ALBERTO R. MALASOMMA, New York, N. Y.

935,048. COUPLING FOR THE INFLATING-VALVES OF PNEUMATIC TIRES. CHARLES MCNELLIS, Chicago, Ill.

935,338. MILKING-MACHINE. WILLIAM J. UEBLER, West Schuyler, N. Y.

935,390. DAMPER-REGULATOR. RICHARD P. MITCHELL and ROBERT V. BRAWLEY, Statesville, N. C.

935,442. GOVERNOR. GEORGE H. WILSON, Spokane, Wash.

1. A governor, comprising a brake mechanism, an air pump, and a cylinder provided with an air vent and containing a resistance piston connected with and controlling the said brake mechanism, means whereby the movement of the piston to operate the brake will gradually close a vent, the said cylinder being connected with the said discharge of the said air pump to actuate the piston.

935,537. PNEUMATIC MOTOR. REINHOLD A. NORLING, Aurora, Ill.

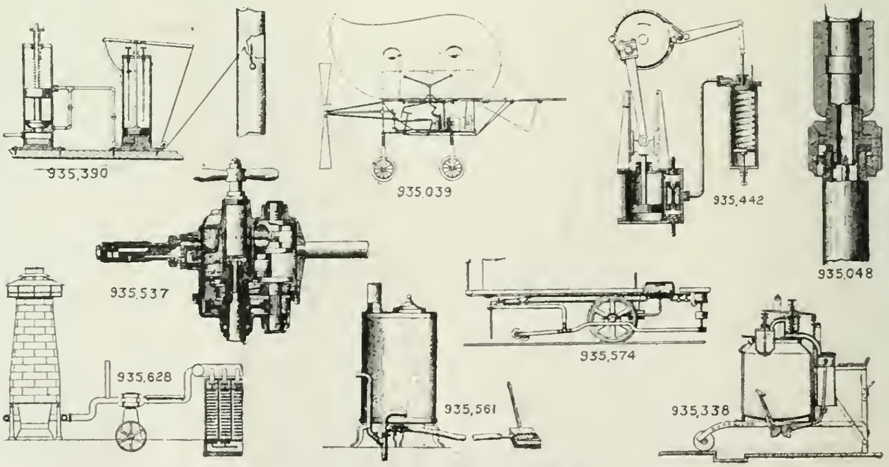
935,561. HYGIENIC HEATER. HENRY L. STUTTS, Green Hill, Ala.

935,574. CAR-FENDER. CHARLOTTE ARNESEN, Portland, Oreg.

1. The combination of a fender mounted for vertical movement, fluid pressure actuated means to operate the same, a movable releasing element in advance of the fender, fluid pressure actuated means to operate the releasing element, and means actuated by an initial movement of the releasing element, to put both the means for operating the fender and the means for operating the releasing element into operation.

935,628. METHOD OF OPERATING BLAST-FURNACES AND CONVERTERS. JAMES GAYLEY, New York, N. Y.

1. The method of operating blast furnaces or converters, using an air blast consisting in reducing the moisture content of the air to a small and substantially uniform percentage, supplying the dried air at a substantially uniform temperature and weight to blowing engines, and then forcing this air to the furnace or point of use; substantially as described.



PNEUMATIC PATENTS SEPTEMBER 28.

NOTES

H. H. Stock, for many years editor of *Mines and Minerals,* has been appointed professor of mining engineering at the University of Illinois.

In the coal mining district near Barcelona, Venezuela, the coal is transported from the mines to the railroad, six miles, in kerosene boxes on burros.

The better grades of carbons for diamond drilling are selling at as high as $85 per carat. Fifty years ago they were worthless, and in the '70s sold at as low as $5 per carat.

T. Commerford Martin, for more than a quarter of a century editor of the *Electrical World,* recently resigned that position to accept the general secretaryship of the National Electric Light Association.

Small diamonds that used to be lost to the miners are now saved by passing the debris with the aid of water over a greased table The grease holds the diamonds, while all other solid particles are washed away.

The American Society of Mechanical Engineers has accepted an invitation from the Institution of Mechanical Engineers to hold its spring meeting for 1910 in England, at such time and place as may be selected by the Institution.

Much railroad work would never be undertaken were it not that the shortening of a line, the lowering of a grade, or the improving of a roadbed, will allow the reduction of running time and thus often secure a mail contract.

The Lucin cut-off on the Union Pacific R. R. cost $10,000,000, reduced the length of the line 44 miles, eliminated more than 1,500 feet of heavy grade and 3,919 degrees of curvature, or more than 10 complete circles, and effected an operating economy of from $900,000 to $1.000,000 per year.

Sixteen tons of American eagles were received recently at Washington, D. C., in a single shipment. There were four of them, and they are to be placed over the state and carriage entrances of the new Union Station. Designed by Augustus Saint Goudens, they are each 8 feet high and the spreading wings measure 12 feet from tip to tip.

On one of the government railways in New South Wales, Australia, the construction of a new line eliminates a switchback, and secures easier grades and reduced curvature, although at immense construction cost. Five tunnels have been completed and five more are in progress. Electricity is used for lighting and for driving the air compressors.

An emergency respirator for use in mines has been invented by Mr. Clarence Hall, of the U. S. Geological Survey. The "respirator" consists of two cans, through one of which is drawn the air which is to enter the lungs. This air is here enriched with oxygen, generated by dropping water upon sodium peroxide. The exhaled breath passes through the other can, containing lye to absorb the carbon dioxide.

Prof. Charles Richet, of Paris, has devised a means for purifying the air in rooms. His apparatus is an air filter which mechanically sterilizes air. Very fine drops of glycerine are scattered along the walls of a cylinder containing a suction fan. Each particle of air drawn in by the fan is freighted with glycerine, and hence tends to drop, thereby carrying with it the germs, dust, and microbes with which it may be laden.

An unusual method of tunnel drainage was used by Mr. H. H. Dalrymple-Hay in the Hampstead tube of the London underground railways. The tunnel was built under air pressure and there was considerable leakage into it. Instead of putting in a pump Mr. Hay put down a well hole, 11½ in. in diameter, carrying it 210 ft. below the grade of the tunnel and terminating in a porous stratum. The hole was cased through the water bearing stratum surrounding the tunnel. It was found that 167 imp. gal. passed down the hole per hour.

Rubber is in such demand for modern uses that not only are new plants supplying it being sought, but eager efforts are being made to produce substitutes. Artificial indigo and artificial camphor are among the great successes of modern chemistry, and artificial rubber seems to be near at hand, as the production of caoutchouc by synthesis has been already announced by Mr. Allsebrook and Dr. Docherty of Burton-on-Trent, England.

After exhaustive tests, in which the power saving when operating at great depths was found to be as high as 50 per cent., the Homestake mine, of Leeds, South Dakota, operating the largest mechanical mining equipment in the world, has recently installed fifteen electric air drills. Several drills of the same type have been purchased by the Wenatchee Canal Company, and are now being used in driving the big tunnels just west of the Columbia river.

Editors generally will please put us on record as not wishing or asking any favor on account of being advertisers. We buy their space at the lowest possible price. Sometimes at a price so low they squeal, and we therefore appreciate any reading notices they are willing to give us, and they are free to chuck into the waste basket any of the "stuff" they think savors too strongly of an advertisement or is not of any possible interest to their readers.—*Graphite.*

Another line of railway, the fourth, across the Andes to the Pacific coast has been begun. It is from Arica, on the Pacific, to La Paz, in Bolivia, a distance of 292 miles, but rising to an altitude of 11,900 feet above sea level. The average gradient on the higher levels will be 4.5 per cent., with a maximum of 6 per cent., and at several places the railway will have to be worked on the rack system. There will be 48 bridges and 70 tunnels. A hydroelectric station is to be erected to generate sufficient power to run the trains to the summit, besides furnishing power and light for Arica.

Samples of air at a height of nearly nine miles have been recently obtained and examined for the presence of the rare gases. The collecting apparatus, carried by a large balloon, is a series of vacuum tubes, each drawn out to a fine point at one end. At the desired height an electromagnetic device, connected with each tube and operated by a barometer, breaks off the point of the tube, admitting the air. A few minutes later a second contact sends a current through a platinum wire around the broken end, melting the glass and sealing the tube.

The industry of aerial navigation is said to be developing in France with astonishing rapidity. There are in Paris in full operation 15 factories for the manufacture of materials and the construction of aeroplanes of all sizes, forms, and designs, besides a dozen or more inventors who are making under cover and more or less secretly individual machines which embody their special and more or less original ideas of what the aeroplane or dirigible air ship of the future ought to be.

In an article in the *Elektrotechnische Zeitschrift* Mr. L. Zehnder discusses the danger turbances, and the methods of avoiding disto ballons and aeroplanes of electrical disastrous effects. He points out that the electrical conditions of the air are subject to great variations during thunder storms and that the atmospheric charges may change suddenly in sign. In clear weather an ordinary balloon without metal parts is not exposed to any danger so long as it floats in the air; but in the modern dirigibles much of the framework consists of conducting materials, which add to the danger. Also a balloon may be charged with electricity and a spark produced when contact with the ground is made, setting fire to the gas.

Many unsuccessful attempts to produce a non-inflammable celluloid have caused new substances of the kind to be received with skepticism, but it is claimed that the cellite of Dr. A. Eichengrun, now made at Dusseldorf, Germany, has withstood tests proving it to be a cheap and useful material. Celluloid is a mixture of collodion cotton, a nitro-cellulose less highly nitrated than guncotton, with camphor and suitable coloring matters. In cellite the nitro-cellulose is replaced by an acetylcellulose, made with acetic acid instead of nitric acid, and variety is given to the product by substituting different artificial camphors for ordinary camphor. Cellite is thus made soft, hard, elastic or flexible. It is slow burning, with none of the explosive combustibility of celluloid.

COMPRESSED AIR MAGAZINE

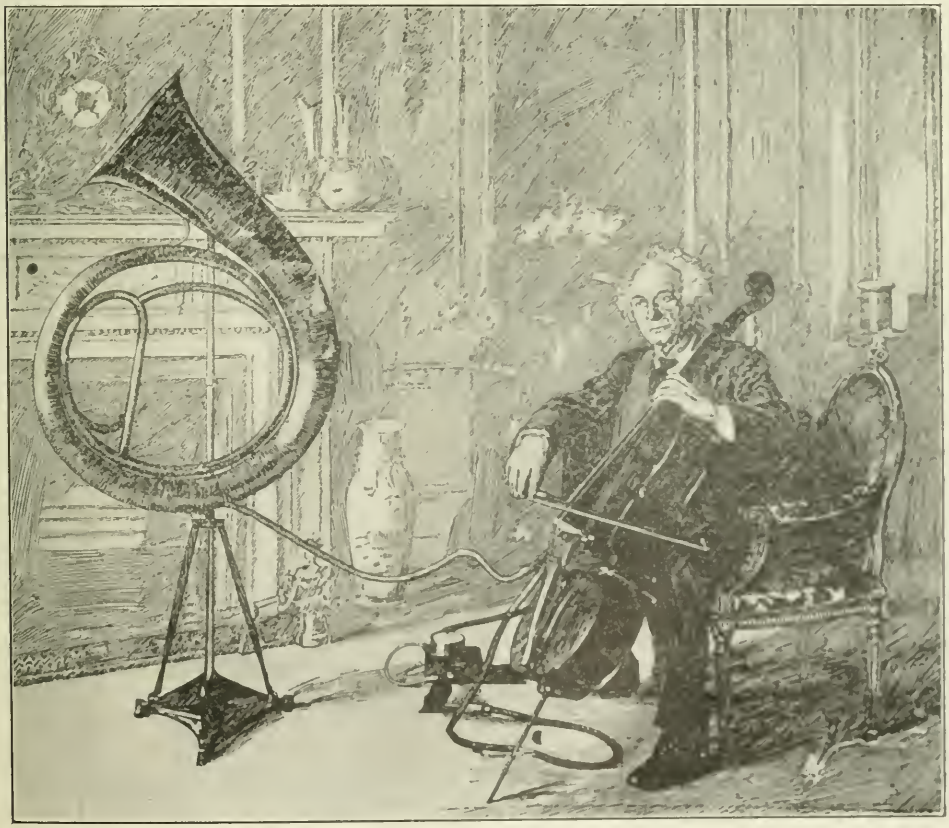
EVERYTHING PNEUMATIC.

Vol. XIV DECEMBER, 1909 No. 12

THE AUXETOPHONE OR MUSIC MAGNIFIER, COMPRESSED AIR THE AGENT

The auxetophone, the invention of Hon. C. A. Parsons, of steam turbine fame, was exhibited at a recent concert in London. The cut (from Popular Mechanics) shows it as it appears in use. It is an attachment for musical instruments which by the aid of compressed air increases the volume and intensity of tone while retaining all the characteristics of the instrument. The following description is furnished by the English correspondent of the Scientific American:

The auxetophone may be best described as a



THE AUXETOPHONE.

comb or multiple-reed valve of aluminum, which comb is hinged in such a manner that each tooth of the comb can vibrate at a variable distance from a corresponding slot in a little box to which compressed air is supplied at about five pounds pressure. The farther away the teeth are from the slots, the greater is the flow of air, and *vice versa*. The flow of air is controlled by a valve, and when caused to vibrate, the air transmits corresponding sound waves into the trumpet.

When the auxetophone is applied to the cello or any other stringed instrument, the valve is connected by a rod of aluminium with the bridge of the instrument. Thus the valve is caused to vibrate in accord with the characteristic tone of the instrument. The sound issuing from the trumpet, though in many respects identical with that of the instrument itself, is at the same time richer in character and greater in volume.

A special bar is carried across the sounding box of the instrument to support the multiple-reed valve and its box. The current of compressed air enters the box at its lower end. The aluminum connecting rod between the valve and the bridge of the instrument is clearly shown.

The air is compressed in a small portable cylinder. The current first passes through a pressure gage at the player's foot, the dial of which can be instantly and easily read and followed. From the pressure gage it passes to a small air filter, which removes all suspended impurities. Then it passes to the lower end of the valve box mounted on the instrument. Between the pressure gage and the filter is a small pedal, by means of which the player can modulate the flow of the compressed air by means of his foot.

The horn is mounted on a stand beside the instrument, and a flexible pipe coupling connects the valve box of the instrument with the horn. The valve mechanism support is so made that it can be attached to or detached from the instrument in a few moments.

At the concert previously mentioned, the possibilities of the invention were very strikingly evidenced. The tone of the instrument was appreciably fuller, richer, and stronger when the auxetophone was attached, the harmonics were clearer, and the high-pitched notes were more clearly defined than is possible without the attachment. In the fortissimo passages the tones had a solid, well-rounded ring of great volume, while in pianissimo the expression of the artist was well produced with a softness accompanied by distinct clearness of the tones.

COMPRESSOR DESIGNING—THE DISTRIBUTION OF THE LOAD

By Frank Richards.

The air compressor shown in Figs. 1 and 2 may be regarded as a standard machine for the special line of work for which it is adapted. There is that which is picturesque for the engineer as well as for the landscape gardner, and this is a picturesque and interesting machine, embodying a number of details of ingenious design which are well worth considering. The compressing of air is not in any case as simple an operation as the pumping of water, and when high pressures are required, involving, as in this case, multiple stage compression, the problem of equitably apportioning the work and the effect for each step of the operation, the providing for the easy flow and the efficient cooling of the air between the stages, the reduction of machine friction to a minimum, the providing for the proper lubricating of all the working parts, the arranging of all for ready accessibility when wear or accident makes it necessary, constitute in all an intricate problem, the solution of which is well worth looking into. Nothing, of course, is final, and everything achieved is a challenge to surpass it, so that doubtless later there may be a better machine than this, or than any we now know of, and we must note its points of excellence while we may.

This is a three-stage air compressor designed to work to 1,000 pounds gage pressure, with a free air capacity of about 50 cubic feet per minute. It is a power-driven machine, the type of power application being according to circumstances. As here shown it has a pulley for a belt drive, but it may also be driven by a chain, by gearing, a Pelton wheel on an extension of the shaft, or by a direct-connected electric motor.

The dimensions of the cylinders are 8-, 5- and 2⅜-inch diameter, respectively, by 8-inch stroke, and the normal speed is 150 revolutions per minute, giving a piston speed of

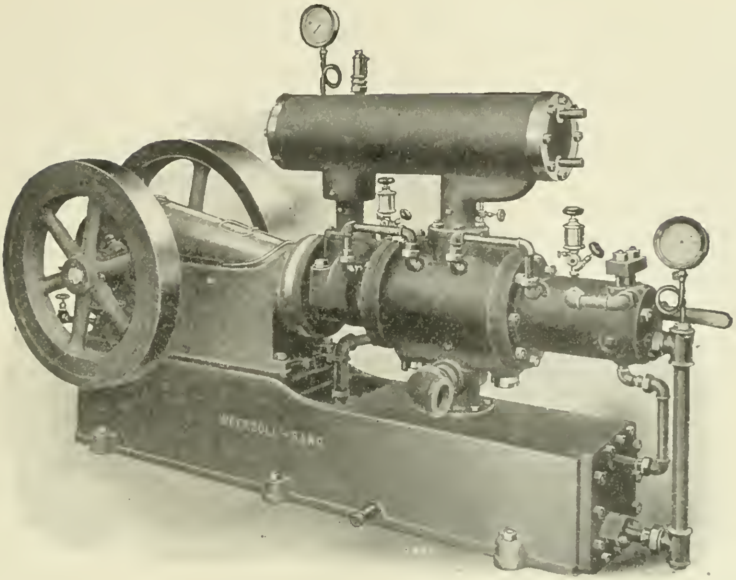


FIG. 1. THREE-STAGE AIR COMPRESSOR, TO COMPRESS TO 1000 POUNDS PER SQUARE INCH.

200 feet. The low-pressure, or intake, cylinder is double-acting and the other two are single-acting. The three cylinders are in a straight axial line, one piston-rod extending from the cross head through all the pistons. The low-pressure cylinder is between the other two, the intermediate cylinder being in front, or toward the crank, and the high-pressure cylinder at the back. The pistons of the intermediate and of the high-pressure cylinder are, in fact, plungers on each side of the low-pressure piston. The working area of the low-pressure piston on each side is, therefore, only that portion of the piston which surrounds the

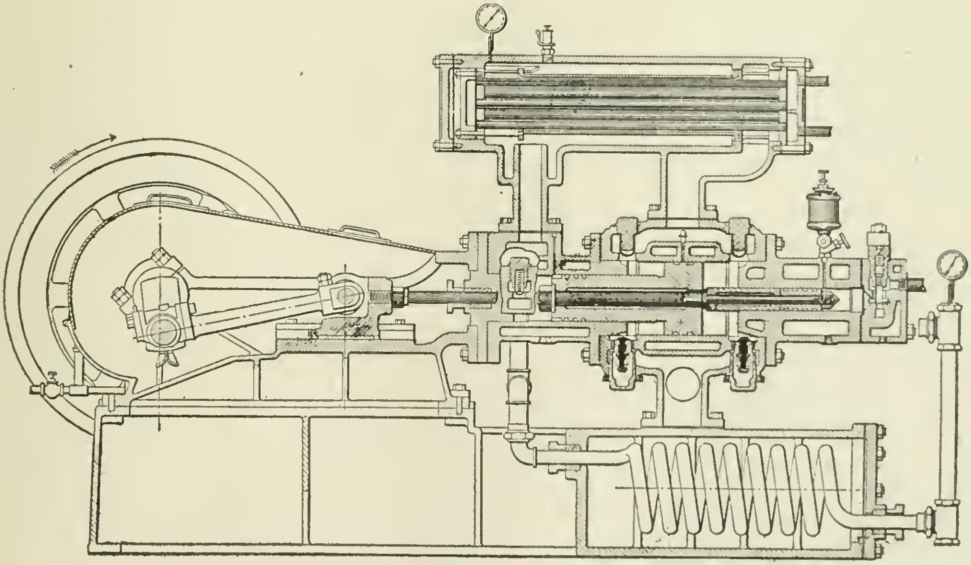


FIG. 2. VERTICAL SECTION OF THREE-STAGE COMPRESSOR.

plungers, and these areas are quite different on the two sides of the piston on account of the different plunger diameters. This arrangement gets rid of all cylinder heads or partitions and stuffing-boxes between the cylinders. The only stuffing-box for the entire machine is that in the head next to the cross head and opposed to the working pressure of the intermediate cylinder. The piston rings are the only packings required besides this one stuffing-box. The packing rings for the low-pressure and the intermediate pistons are sprung into grooves turned in the solid metal. In the high-pressure piston or plunger the grooves are not turned in the solid but are formed by removable sections which fit the piston-rod and also the cylinder bore, and which are cut away at the outer corner to form the grooves for the rings. When the main portion of this piston is in place in the cylinder, a packing ring is slipped in to fit against it; one of the movable sections of the piston is then slipped in against this, then another ring, then another piston section with a washer and nut outside, which secures all. The middle or low-pressure piston has a taper fit on the rod, and is secured by a nut outside the intermediate plunger, which thus locates it precisely and holds it securely.

The actual working clearances of one of these compressors, as determined by the inspector, were: for the low-pressure cylinder, 3/32 inch and 3/32 inch; intermediate cylinder, ⅛ inch; high pressure, ⅛ inch. The distribution of the pressures and the apportionment of the work of compression throughout the cycle of operations of this compressor are such as to make the work for each stroke nearly the same.

On the forward stroke, or with the pistons moving toward the crank, the low-pressure piston and the intermediate piston are both compressing to their respective pressures, and the receiver pressure against the high-pressure plunger is assisting; that is, its thrust at practically constant pressure is to be deducted from the total work done by the other two pistons. On the backward stroke, the low and the high-pressure pistons are compressing, and the receiver pressure against the intermediate piston is assisting in the work. By calculation based on the assumption that the compression is adiabatic, it is found that the horse-power required for the forward compression stroke of the low-pressure cylinder is 2.79, and for the same stroke of the intermediate cylinder, 8.52 H.P. The total horsepower resistance for the forward stroke is 8.52 + 2.79 = 11.31 H.P. The intake pressure against the high-pressure plunger which is approximately constant, is sufficient to develop 3.13 H.P. which is to be deducted from the working horse-power of the other two cylinders giving us as the net horse-power for the forward stroke 11.31—3.13 = 8.18 H.P. For the back stroke of the low-pressure piston the horse-power resistance equals 4.17 H.P., which is, of course, greater than for the forward stroke, because of the increased piston area. The resistance for the working stroke of the high-pressure cylinder equals 8.93 H.P., giving a total for both the low and high-pressure cylinders of 4.17 + 8.93 = 13.10 H. P. From this it is necessary to deduct the power due to the intake pressure against the intermediate piston, which is found to be 3.13 H.P. The net power for the back stroke then will be 13.10 — 3.13 = 9.97 H. P.

While the work of the two strokes is so nearly equal, that of the back stroke is the larger, which is as it should be, as this occurs on the thrust of the connecting-rod instead of on the pull. A sufficient reduction of the terminal delivery pressure would equalize the work for the alternate strokes.

As before stated, adiabatic compression is assumed in each cylinder, with efficient intercooling between the stages. The cylinders are all very completely water jacketed, so that the temperatures of the working surfaces are kept down, and satisfactory lubrication is maintained, but there is little cooling effect upon the body of air in the cylinders during the operation of compression. The circulation of the cooling water is accomplished by a single continuous flow through both intercoolers and all the water-jackets, there being no places where the water can remain without change. The efficiency of the intercooling is sufficiently indicated by the fact that the temperature of the air leaving the second intercooler and entering the last compressing cylinder was found upon a prolonged test to be the same as that of the initial intake or 70 degrees, and the temperature of the air as finally delivered, there being no after cooler, was 188 degrees. The final temperature for perfect adiabatic, single stage compression to 1,000 pounds would be above 1,250 degrees, which would be prohibitive in practice.

In a test which was made of one of these machines, in which the number of strokes of the compressor required to fill a receiver of known capacity was ascertained, the volumetric efficiency of the compressor, or the ratio of the volume actually delivered to the total piston displacement of the low pressure cylinder, was determined to be 0.927.

This compressor considered in detail will be found to be an extremely simple one when the complication of function is allowed for. The main frame combines in itself all the particulars upon which perfect and maintained alignment depends. The first cylinder has a true seat against the frame and the other cylinders successively locate themselves by their seating, all the joints being scraped and the faces going together without packing. Every valve is independently accessible by the removal of its cap. Taking off the high-pressure cylinder (which is no more work than the removal of a cylinder head) makes all the pistons easily removable, and gives complete access to all the cylinder interiors.—*Machinery.*

CHARACTERISTICS OF CENTRIFUGAL AIR COMPRESSORS OR BLOWERS

The positive-pressure blower operates at constant volume and variable pressure, when the speed is held constant. That is, with every stroke of a reciprocating compressor or every revolution of the cycloidal type, a certain definite volume of air is taken into the compressor and discharged, the pressure of the air depending on the size of the orifice through which it is forced. Positive-pressure blowers are usually equipped with safety valves to prevent excessive pressure rise when delivering small quantities, and this leads to waste of power when operating at light loads.

The centrifugal compressor requires no safety valve and is thus much more efficient at light loads than the positive-pressure machine. The main characteristic of a centrifugal compressor is just the reverse of what it is in the positive-pressure blower. The pressure is nearly constant at constant speed, while the volume can be varied through a wide limit. The accompanying curve shows how the pressure varies in a centrifugal compressor from no-load quantity to load and a half.

By automatically varying the speed of a positive-pressure blower it can be made to work as a constant-pressure machine through a limited range, while by varying the speed of a centrifugal compressor it can be made to work as a constant-volume machine through a limited range.

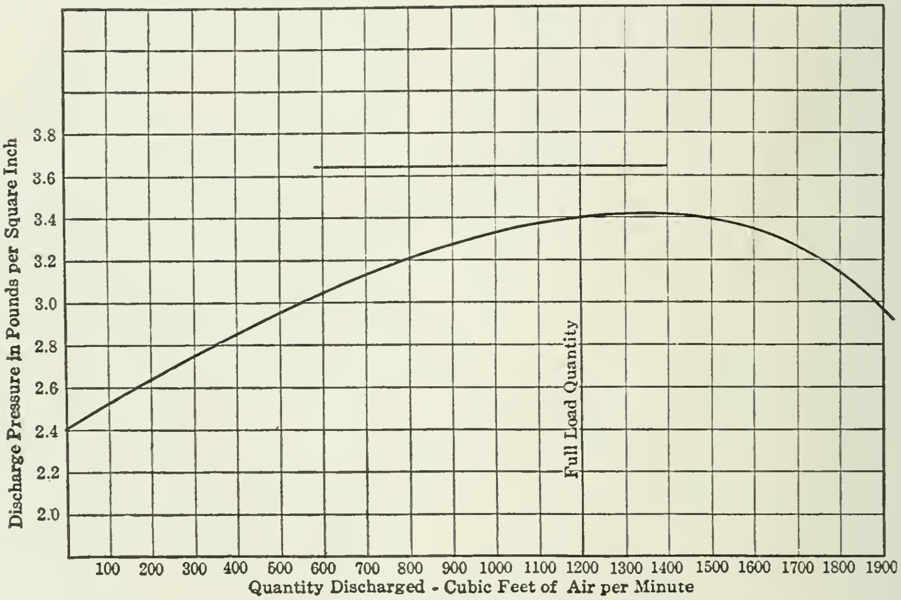
In the centrifugal compressor this change of speed is obtained automatically by having a floating air governor attached to the inlet pipe of the compressor. This governor consists of a sheet-iron cone inside of which is a circular disk supported by the current of inflowing air. The height at which this disk floats depends on the quantity of air flowing. The disk is connected by levers, with the speed-controlling device of the driver, so as to change the speed with any change in the quantity of air flowing, and thus hold the quantity constant at the volume at which the air governor is set to operate.

When starting a centrifugal compressor the blast gate should be closed until the machine has been brought up to speed and then it should be gradually opened. All openings closed gives light load on this type of compressor. This is the hardest thing about the machine for operating engineers to grasp, as it is directly opposed to positive-pressure-blower practice. The machine should never be run with the piping wide open to the air. Under these conditions it will deliver several times the full-load volume and since the pressure does not drop off a great deal at heavy overloads, as can be seen from the curve, the driver will be heavily overloaded, and if the compressor is motor-driven, the motor armature will be very likely to be burned out. With a turbine-driven machine no particular damage would be done.

It might be well to state for the benefit of those not familiar with this type of compressor that, due to the high speed at which they run, they are always direct-connected to the driver and the drivers are either high-speed motors or steam turbines.

The one great fault with this type of compressor is the liability of the impeller wheel to vibrate. The inherent characteristic of the machine requires very high wheel speeds. A common practice is to run a 30-inch wheel at 4,000 revolutions per minute. This gives a peripheral velocity at the rim of 31,400 feet per minute. While this is not a high value for turbine practice, it is for wheels constructed as are impeller wheels, and it requires the most careful balancing of the wheels to prevent excessive vibration at this speed. Excessive vibration may cause the impeller blades to break off, due to fatigue, and is almost certain to put the driver out of commission.

When two centrifugal compressors are used to pump into the same main header, a check valve should be placed between each machine and the header. If this is not done and it is attempted to run much under full-load quantity to the rising characteristic, and this in turn for both machines, one or the other of the machines will take all of the load and thus run at a heavy overload, while the other machine will be running light. The reason for this is that centrifugal compressors have a rising-pressure characteristic from no load up to nearly full load; that is to say, an increase in quantity of air delivered by the compressor gives an increase in pressure. This can be readily seen from an inspection of the curve. When two compressors are pumping into the same header there is a slight pulsation of pressure in each machine and as one compressor happens to reach momentarily a slightly higher pressure than the other, the slight increase in pressure will increase the quantity slightly on this machine, and the increased quantity will give a still higher pressure, due a larger quantity. This building-up process will continue until one machine is carrying nearly all the load. This tendency can be overcome by having the speed of the driver drop off as the load increases, and this change in speed can be obtained in turbine-driven machines by a simple adjustment of the governor for falling speed, and in direct-current motors by having them heavily compounded.—*Howard M. Nichols in Power and the Engineer.*



CHARACTERISTIC CURVE OF CENTRIFUGAL AIR COMPRESSOR

DYNALITE AND SAFETY

Unless both heat and pressure combined are used on dynalite it will not explode. There is one case on record where a cartridge had been placed in frozen ore. One of the workmen, not knowing that the cartridge had been placed there, ran a red hot iron in the hole for the purpose of making it deeper. The iron ignited the dynalite and it burned up in the hole but did not explode. A party was loading a large blast with dynalite and had it nearly completed, when one of the men knocked a piece of flint rock into the hole, unknown to the manager, who was himself in charge of the blast. The workman took a steel drill to break the stone. He struck a spark, ignited the dynalite and, while it was burning, threw a pail of water in the hole. All ran for their lives but no explosion followed, although there were forty pounds of dynalite in the blast.

The claims made by F. H. Briggs, the vice-president and general manager of the American Dynalite Co., regarding dynalite have passed from the realm of uncertainty to an everyday matter-of-fact certainty, proved by the accidents, mishaps and careless handling of dynalite during the past three years. Mr. Briggs has a most direct way of convincing people that his claims regarding dynalite are absolutely within the limits of truth. For instance, he takes a visitor through the mills, he shows him all there is to be seen there. Then he does some things which makes the visitor's knees tremble, and his heart beat faster. He takes a loaded tube of dynalite, lights it with a match and holds it aloft like a Roman candle and, while burning brightly, hurls it against a tree. "You see," he says, "it doesn't explode." He inserts a fulminating mercury cap into the loaded tube, attaches a fuse, places another cartridge six inches distant, lights the fuse, retires with his visitor to a safe distance and watches results. A loud detonation, an upheaval of rock and dirt, the cartridge placed beside the one exploded is hurled 50 feet or more from the spot, but the concussion and the shock have left it whole. He demonstrates that it is a nonsympathetic explosive, by pouring a string of dynalite on a rock, taking a hammer and striking it. Only the dynalite grains directly under the blow of the hammer explode, making a noise like a percussion cap. The dynalite grains near those exploded are not disturbed. People using explosives are beginning to realize that dynalite is not dangerous, and wherever prejudice existed it is giving way to a better knowledge of this high and practically safe explosive.—*Rock Products.*

LIQUID AIR OR CARBON DIOXIDE FOR SKIN DISEASES

An American physician tried liquid air and carbon dioxide and obtained more or less success in cases of tuberculous abscesses, moles, pimples, and superficial cancer of the skin. Cotton wool, wound tightly on the end of a rod, is dipped into the double-walled glass flask of liquid air and then pressed lightly on the affected part of the skin. The skin freezes and becomes inflamed and in from 10 to 20 days the morbid growth sloughs off.

But liquid air is expensive and it also acts too energetically. An equaly efficient, but cheaper and more manageable agent is carbon dioxide, which was first employed for this purpose by Pusey. From the steel cylinder which contains liquefied carbon dioxide, the vapor is allowed to escape into a glass tube. Here it condenses into snow, which is compressed by a piston into a hard mass. This can be trimmed to the size and shape of the morbid growth to which it is to be applied, and thus the freezing of the surrounding healthy skin can be avoided.

The temperature of carbon dioxide snow is —130 deg. F., while that of liquid air is about —290 deg. F. The snow is cold enough, however, to freeze the skin into a hard, white mass in a few minutes. Too long an application may cause necrosis, or death, of the underlying tissues. The skin subsequently becomes slightly inflamed and a blister, similar to that caused by a burn, is produced. In general, freezing and burning produce similar effects on the skin. In two or three weeks the part that has been frozen falls off as a scab, revealing skin of quite normal appearance or marked by a slight scar. The application of this remedy is not attended with great pain. In the treatment of facial blemishes especial care must be taken not to freeze the skin too deeply. The field of application of carbon dioxide snow is extensive. Hitherto good results have been obtained chiefly in cases of lupus, but small tumors, callosities, moles, pimples, etc., also have been treated with success.—*Dr Bergrath in Die Umschau.*

MOISTURE CONTAINED IN THE AIR

By N. A. Carle.

The amount of moisture which can be held by a given quantity of air increases with the temperature and decreases with the pressure. The air is said to be saturated with moisture when it contains all the moitsure which it can hold at that temperature and pressure without condensation.

The moisture in the air is known as humidity and is measured on an arbitrary decimal scale, of which 100 is the saturation point of the air, at which it will hold no more water vapor, and 0 is the point at which the air contains no moisture.

The degree of saturation of the air is expressed by the ratio of the moisture actually present in the air to that which it would contain if it were saturated.

When the temperature of air containing moisture is falling, a point will be reached at which the air is saturated with moisture for that temperature and a further lowering of the temperature will result in a condensation of some of the moisture. The temperature at which this occurs is called the dew point of the air.

Air is never perfectly saturated, not even when it is raining; neither is it ever perfectly dry. Relative humidity is not a proper measure of the moisture contained in the air. At a low temperature even a high relative humidity represents a very small amount of moisture actually present in the air, while a low relative humidity at a high temperature represents a great deal.

For different saturation temperatures, the weight in grains of water vapor contained in a cubic foot of air is as follows:

Temperature of Saturation; Fahrenheit Degrees.	Weight of Moisture in a Cubic Foot of Air; Grains.
0	0.56
10	0.87
20	1.32
30	1.96
40	2.85
50	4.08
60	5.74
70	7.98
80	10.93
90	14.79
100	19.77

It is not the intention of the writer to discuss the methods of measuring relative humidity, except to say that two kinds of instruments are used for this purpose, "hygrometers" and "psychrometers." The hygrometer depends on the expansion and contraction of some substance in the presence of moisture in the air, in proportion to the amount of moisture present. A psychrometer consists of two thermometers; the bulb of one being covered with muslin so as to retain a film of water surrounding it. The evaporation of water from the bulb incased in muslin will cool it to an extent depending upon the amount of moisture present in the air. The relative humidity of the air is calculated by means of tables from the temperature of the dry bulb and the difference of temperature between the readings of the two thermometers.

The engineer is concerned with the question of humidity in cold-storage work, refrigeration and the ventilation of buildings. Data are usually available regarding the temperature of the air and its humidity or degree of saturation. What the engineer wants to know is the actual amount of moisture present in the air which is to be handled. The chart on the opposite page is designed to show the weight of water in ounces contained in 1000 cubic feet of air, when the temperature and relative humidity are known.

EXAMPLES.

(1) If the temperature of the air is 70 degrees Fahrenheit and the humidity is 75, how many ounces of water are contained in each 1000 cubic feet of air?

Starting with 70 degrees Fahrenheit, read up to the line showing the amount of water contained in the air at saturation and then across to 75 per cent. humidity and down to 13.7 ounces of water per 1000 cubic feet of air.

(2) If the temperature of the air is 90 degrees Fahrenheit and the humidity is 85, how much water is carried by the air per 1000 cubic feet?

Starting with 90 degrees Fahrenheit, read up to the line showing the amount of water contained in the air at saturation and then across to 85 per cent. humidity and down to 28.7 ounces of water per 1000 cubic feet of air.—*Power and the Engineer.*

The ultra scientists are telling us that a firefly converts the hydrocarbon of its food into light with an efficiency of 40 per cent., while rarely is as much as 10 per cent. of the energy of coal transformed into electrical energy.

The various telegraph and telephone companies in the United States had in use in 1907, 15,072,220 miles of wire. Of this, 12,999,369 miles were controlled by telephone companies. Of this again, 5,092.223 miles were in open aerial lines; 2,917,114 in aerial cables; 4,969,302 underground and 20.730 in submarine lines.

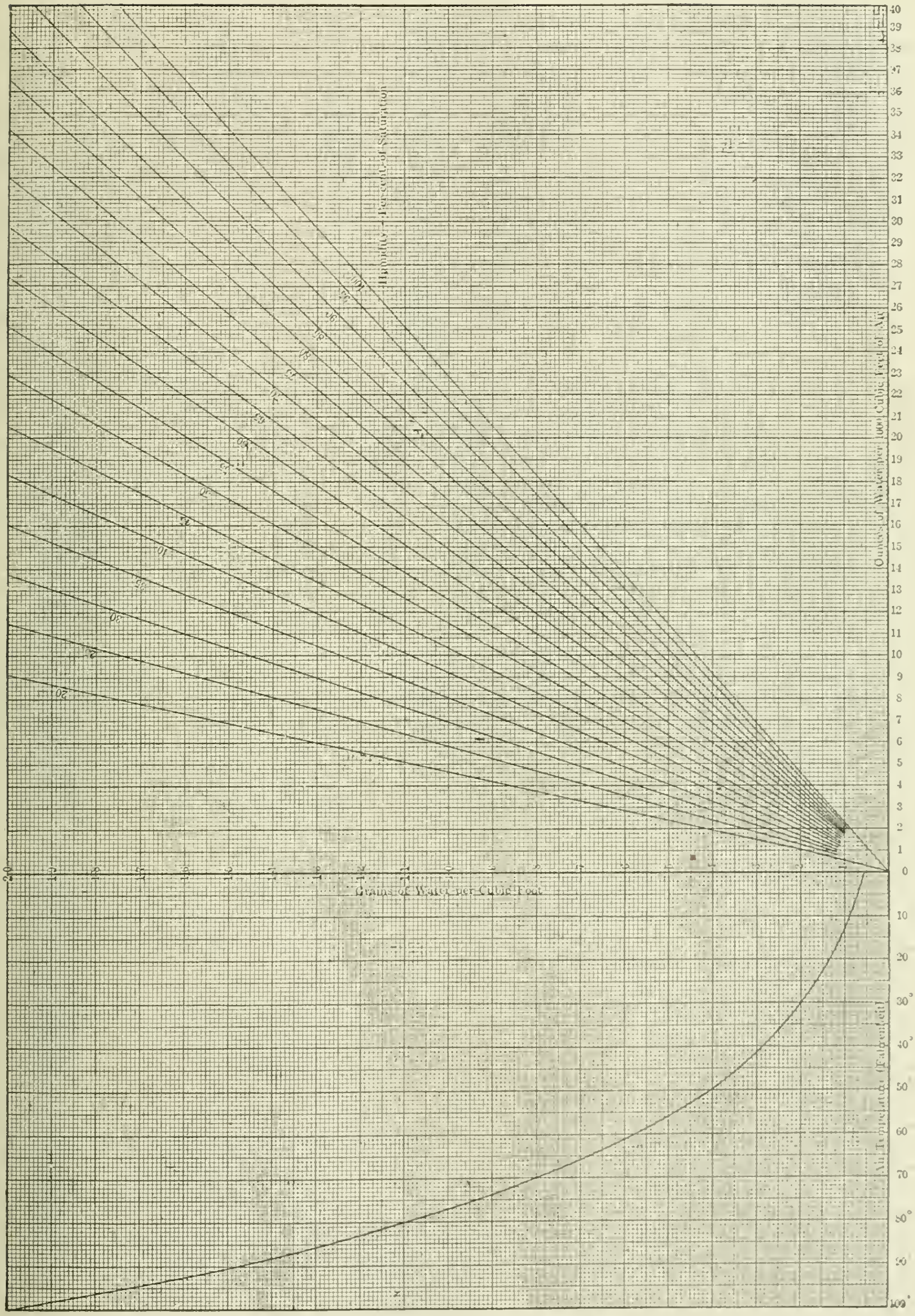


CHART FOR DETERMINING THE AMOUNT OF MOISTURE CONTAINED IN THE ATMOSPHERE

A SUCTION DREDGE RECORD

Along the Clyde river, near the junction of Wayne, Seneca and Cayuga county lines lies an extensive tract of comparatively low, flat land, where the rank cattails nod their russet pompons and mosquitoes grow as big as humming birds. This has long borne the name of the Montezuma marshes. Through this locality the portion of the Barge canal project known as Contract No. 46 has been laid out, and the Kinser Construction Company has undertaken its completion. Quietly and unostentatiously a suction dredge of ordinary type, with timbered, A-shaped, main frame, bearing the 20-inch suction tube and cutter forward, centrifugal pump amidships, and attended by the usual line of pontoon discharge pipes, was built during the present season, in the vicinity and using local facilities. This dredge, the *Montezuma,* was recently placed in commission, and its performance since has certainly established a new monthly record for hydraulic dredges on Barge canal construction, if not indeed a world's record, for dredges of its size and type. Its output for the month of August has been already noted as 251,741 cubic yards, but in the month of September it nearly doubled this record, removing the enormous total of 454,706 cubic yards of material from the prism of the canal and depositing it in adjacent spoil banks. Of course the peculiar nature of the material that this namesake of the imperial Aztec has encountered is largely responsible for the voracious appetite which it has developed. The conditions here are almost ideal for this type of excavator. No vegetable growth clogs its pipes and no rock or stone occurs to hinder the swift revolving cutter-blades.—*Barge Canal Bulletin.*

FUSION WELDING WITH LIQUEFIED LIGHTING GAS

By Alfred Gradenwitz.

The local heating of metals to melting temperature is known to require a point flame of very high temperature, which has so far been mostly produced by oxy-hydrogen torches, i.e., torches to which hydrogen is supplied as fuel, and pure oxygen in the place of combustion air. The flame produced with this torch possesses a temperature susceptible of melting most metals. In fact, the remarkable intensity of oxy-hydrogen flames, as compared with those of a mixture of air and hydrogen, is accounted for by the fact that the oxygen of air contains nitrogen to the extent of 79 per cent. which takes no active part in the chemical process of combustion, while absorbing a large amount of the combustion heat, and thus cooling the flame.

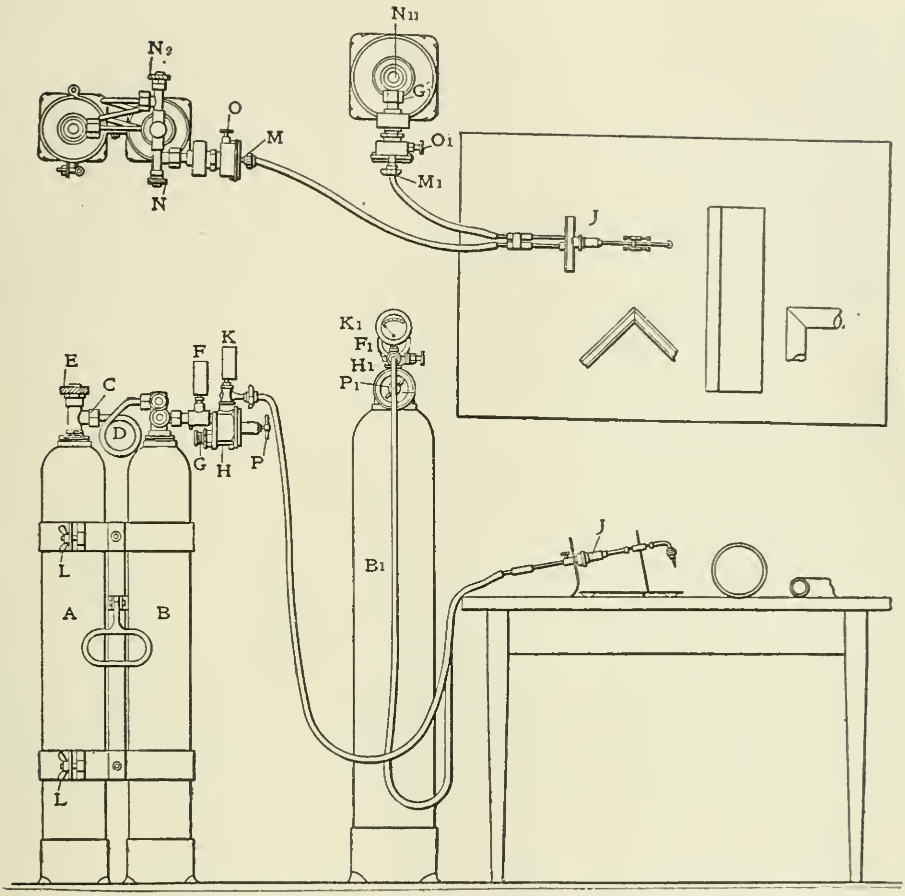
Oxy-hydrogen torches have been used of late years with excellent results in the most varied branches of industry, for fusion welding, the metal being melted locally and allowed to flow together at the seams, without the use of any auxiliary substance or process.

Experience has shown that all gases containing, as elementary components, hydrogen and carbon are adaptable for fusion welding, and the question as to which gaseous fuel is most convenient, mainly depends on the cost of equal amounts of heat units available in the gas as well as on the convenience of the apparatus used. The original oxy-hydrogen process has been found the most convenient and reliable welding method, both gases being sold, in the compressed state, in bottles to which reduction valves for controlling the pressure are readily fitted.

Owing, however, to the considerable specific volume of hydrogen, and the corresponding expensiveness of its transport, this gas has been partly replaced by acetylene.

An important advance has been recently made in the gas industry by Mr. Blau's invention of a process for generating liquid lighting gas. This material, under atmospheric pressure, is gaseous like air, but becomes liquid as soon as its pressure undergoes a moderate increase. In this condition it is extremely suitable for transportation to any distance, like other liquid fuels, such as oil, alcohol, etc.

Blau gas is as transparent and clear as water and possesses, of all commercial gases, the highest lighting and heating values. Similarly to oil gases, it is a combustible material obtained from mineral oils by distillation in red-hot retorts, and comprises the same chemical elements and compounds (hydrogen, methane, saturated and nonsaturated hydrocarbons) as coal gas, though in considerably different percentages. However, this gas is absolutely free from carbon monoxide and accordingly possesses the advantage of not being poisonous. During its solidification, it contracts to about 1/400 of its initial volume



BLAU LIQUID GAS WELDING APPARATUS.

and therefore can be introduced into readily transported steel bottles of different sizes.

This liquid gas has been found to be a fuel which, while being as convenient as compressed hydrogen, is even cheaper in operation than acetylene, for the fusion welding of metals. A further advantage of Blau gas-oxygen welding is the fact that the apparatus (which even in the case of large outputs is readily transported) is free from any water, and accordingly is exposed to no destructive chemical influences such as rusting. On the other hand, the apparatus is as cheap as any, and as the gas is sold in a purified condition, it does not require any cleansing or discharging of refuse, such as lime, slime, etc.

In Fig. 1 is shown a Blau gas-oxygen welding apparatus. This consists of the following parts:

(1) A transportable gas bottle *A* connected to the steel bottle *B* serving as gas reservoir, by the copper tube *D* and intermediary locking valve *N2*.

(2) The reduction valve *H* connected to the locking valve *N* with the pressure gage *F* for determining the gas pressure in the bottle *B*, and the gage *K*, on which is read the gas pressure, controlled by the spindle *P* of the safety valve *G*.

(3) The reduction valve *H*, the jet controller *F*, the pressure gage *K*, and the safety valve *G*, for oxygen.

(4) A Blau gas conduit, with nut *M* for the gas.

(5) A Blau gas conduit with nut *M1* for oxygen.

(6) The welding torch *J* with exchangeable mouth-pieces.

AUTOMATIC UNLOADING DEVICE FOR BELT OR MOTOR-DRIVEN AIR COMPRESSOR

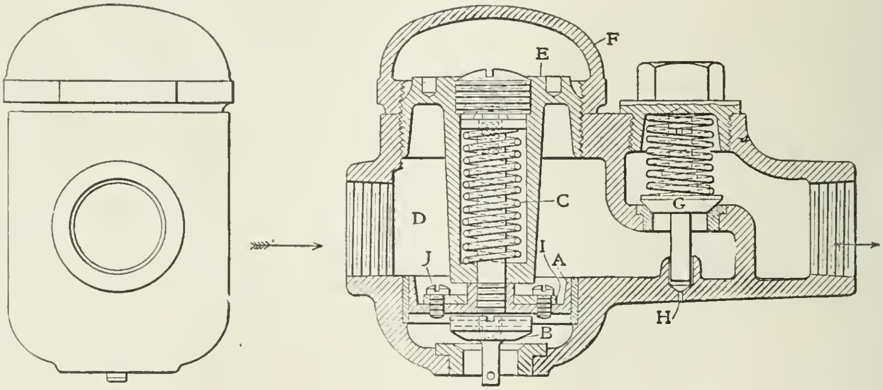
By S. Rice.

In the accompanying sectional sketch is shown an ingenious unloading device for motor-driven air compressors, which device consists primarily of a piston having a bypass, a valve which is closed when the piston reaches its extreme motion against a spring, and a check valve. It is placed in the discharge pipe between the compressor and the reservoir and provides an opening from the discharge pipe to the atmosphere until the motor reaches a predetermined speed for which the device is set.

When the driving power is first applied, the pistons of the compressor will move slowly and will gradually increase their speed as the motor revolutions increase, thus raising the air output of the compressor. The air first passes piston *A* and to atmosphere through valve *B*, which is held open by a spring *C*. As the volume of air becomes greater, the bypass in the piston can no longer take care of the increase as the motor comes up to somewhere near full speed and the pressure rises in chamber *D*. When this pressure reaches a point sufficient to compress the piston *A* and seat the valve, the check valve *G* immediately begins to work and the leakage of air to the atmosphere is cut off by the seating of valve *B*.

The device can be so adjusted that the piston will seat valve *B* when the motor has into the chamber *D*, through the bypass in the reached a limit of approximately three-fourths full speed. When the motor is stopped, the check valve *G* is seated and pressure in chamber *D* is gradually reduced by the leakage of air to the atmosphere through the small opening *H*. When the pressure is slightly reduced in chamber *D*, the piston *A* and valve *B* are drawn in through the action of the spring *C*, thus unseating the valve *B*, and the motor is ready to start again.

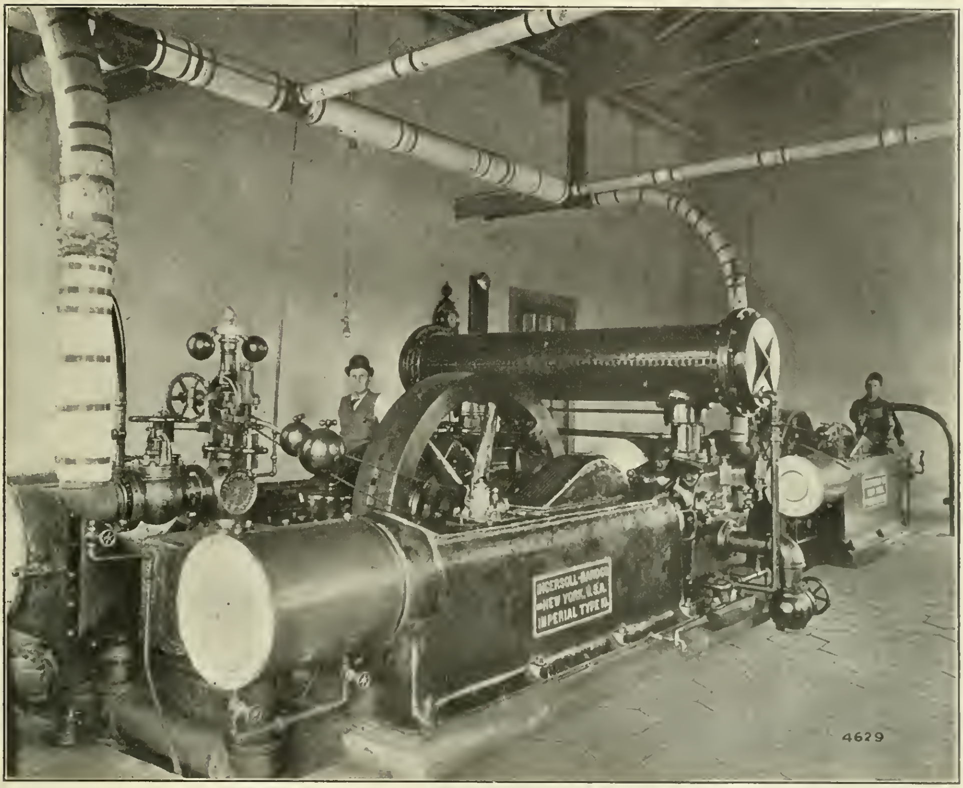
The bypass consists of two good-sized holes drilled in the piston *A*, and two corresponding holes in the plate *I*, which may or may not match, according to the position of plate *I*, and which may be adjusted to give any size of opening desired by means of screws *J*. Further adjustment may also be made by removing the cap *F* and turning the nut *E* holding the spring and locating the inner position of the piston, thus increasing or diminishing the amount of travel that the piston has to make in order to seat the valve *B*.—*Power and the Engineer.*



UNLOADING DEVICE FOR POWER DRIVEN COMPRESSOR.

ONE AIR LIFT SUPPLIES A CITY

The city of Thomasville, close to the southern line of the state of Georgia, has a population of 8,000 and its entire water supply comes from a single well operated by the air-lift. The half-tone shows the air compressor in use, an Ingersoll Rand Imperial, with compound steam and compound air cylinders, the compressor in the rear being an earlier installation by the same builders and now kept as a reserve. The well was bored to a depth of 565 feet, and as the water rises to 185 feet from the surface an ample pipe submergence is provided for.



COMPRESSOR FOR AIR LIFT AT THOMASVILLE, GA.

This plant not only supplies all the water for daily use but provides also for fire service, maintains twenty public fountains and furnishes a railroad with 1,500,000 gallons a month. For fire service there is a standpipe and special piston pumps which give a pressure that dispenses with use of fire engines.

It is found to cost in fuel one cent a thousand gallons for each 100 feet of lift, the total lift in this case being 300 ft. All water supplied is metered and it is sold at 15 cents per 1,000 gallons, net, with a minimum charge of 25 cents per month.

Both this water plant and an electric lighting plant are owned by the city and have been in operation a sufficient length of time to give assured results. The service is all that could be desired and there is always a safe cash balance in favor of the city, although of course no money making is desired or would be permitted by the citizens.

THE MEASUREMENT OF HUMIDITY

By Samuel K. Patteson.

The moisture in the atmosphere affects unfavorably almost every engineering device in which the atmosphere enters as a factor in its operation or design. The gas engine is affected very greatly in its action by the presence of moisture in variable amounts in the atmosphere, and in special developments of this type, the effect is often sufficient to temporarily swamp the engine. The same effect is also present in small marine engines with even more pronounced significance, and its effect is also present in all internal combustion motor installations. Again, cooling towers depend for their efficient action almost entirely upon the amount of moisture present in the atmosphere, and under some conditions of great humidity their effective action is often almost completely stopped. The presence of moisture in the blast in iron furnace operation had long been known to be the chief variable quantity in its effect on the character and uniformity of the product, and only recently have satisfactory devices been constructed for the efficient elimination of the moisture in such cases.

In air compression as well the presence of moisture in the air is well understood, and its limiting effect on efficiency can be greatly diminished by proper study and prevention of this phenomenon. These developments represent a comparatively few of the processes in which the presence of moisture in the air affects the efficiency of the operation, but they are essentially the more important classes and give a fair idea of the importance of this factor in engineering progress.

The problem itself from a physical or engineering viewpoint is essentially a single development of the broader one involved in the mixture of two or more vapors or gases, and the laws governing their relative proportions under variable conditions of temperature and pressure are fairly well understood, although this development is one in physical science which is undergoing rapid progress to-day. The basic conditions or laws which govern all these relations are primarily the fundamental laws of gases and vapors. Thus Boyle's law holds for a gas independent of the presence of some other gas or vapor. In an equal sense Charles' law, showing relation between pressure, volume and temperature of the gas, is equally true independent of the presence or intimate mixture of some other gas or vapor in the one under measurement. Dalton's law is the particular one that applies in these conditions, and, stated briefly, it consists in the fact that all gases or vapors exist in conjuction with each other according to exactly the same laws that would hold if the others were not present.

Water vapor occupies space filled with air in precisely the manner that water vapor would tend to occupy space or vacuum if the air were not present. The ordinary atmospheric pressure of 14.7 pounds to the square inch is, therefore, according to this law, a combination pressure, due to the pressure of the atmosphere alone and the pressure of the water vapor present. The water vapor exists in quantities in this air dependent upon the temperature alone, and varies with it, and also with conditions which affect the degree of saturation. Thus, according to Dalton's law, if a cubic foot of dry air is taken, it will exert a definite pressure of, say, 14 pounds to the square inch. If a drop or two of water is injected into this, under normal conditions, the pressure will immediately rise from 1-2 to 1 pound to the square inch, and the pressure of the mixture will then be, approximately, 15 pounds, as recorded on an absolute pressure gauge. If a drop or two of alcohol is then injected into the mixture, the vapour of this liquid will tend to occupy the space in precisely the manner the water vapor has done and just as though the others were not present. Under these conditions the pressure will rise again from ¼ to ¾ of a pound, or a variable amount dependent upon the nature of the vapor and the temperature.

As far as known, pressure can be increased indefinitely by this process by simply increasing the number of volatile liquids which are injected into a given space, and such pressure could undoubtedly be used for the production of work. However, the extent to which Dalton's law is true under such extreme conditions is problematical, and this development represents another phase in physical science which is undergoing investigation at the present time. The simple problem of the mixture of water vapor with the atmosphere is, as has been said, fairly well understood and represents to-day the chief development in which the practical aspect has been forced to the front.

The water vapor in the atmosphere can be readily removed by any chemical dryer. Thus if a given quantity of air is enclosed in a vessel containing lime or sulphuric acid, and the vessel shaken up, if desired, for more complete effect, all the moisture will be removed from the air and the pressure of the latter will fall. If the chemical agent, lime, calcium chloride, sulphuric acid or any well known dehydrators are weighed before and after this treatment, the moisture content for this quantity of air is absolutely determined, and a device or mechanism for the performance of this experiment readily and accurately is known as a chemical hygrometer.

While the actual quantity of water in air is of very great importance under many operative conditions, its relation to another value, namely, the saturation content, is often of much greater significance. In general, a saturated vapor can be defined as a vapor in which the quantity of material held is at its maximum. Any increase in the material present in the space either due to actual introduction, or to an increase in density caused by pressure, will cause a deposition or condensation of a portion of this vapor into its liquid form. It is analogous to what is known as the dew-point in atmospheric conditions, and at this latter temperature the ordinary air contains saturated water vapor. Any variation, as stated, or a diminution in temperature results in a condensation or diminution in the weight of the vapor present. Thus one condition for the presence of a saturated vapor is the presence of a liquid surface of the same material immediately contiguous both in regard to time and place. Thus the water vapor in the air is saturated or not saturated, dependent soley upon the presence of large quantities of water in the vicinity or the close time relationship of the air in its contact with this surface.

When a gas or vapor is heated, it tends to expand and occupy a larger space. Hence a saturated vapor gradually becomes in an unsaturated condition with rise in temperature, and is capable of absorbing, on contact with its own liquid, an amount of the material in the form of vapor sufficient to render it saturated. The amount of saturated vapor which the air can, therefore, hold at any given temperature is readily determined by a reference to the steam tables for this temperature, and this steam pressure in practice is represented by a certain definite fraction of what is known as ordinary atmospheric pressure. The relation of the amount of water vapor present in the air to the amount that the air could contain if the steam or vapor existed in a saturated state, is known as the hygrometric state or percentage of humidity, and is of very great importance in engineering practice, especially in cooling tower operation and allied phenomena, since it represents the capabilities of the air in regard to its absorptive power for moisture present in surrounding bodies, and hence its cooling effect in cooling towers and its drying capabilities as a dehydrator.

While the ratio of the amount of moisture present in any definite amount of air to the amount that it should contain at this temperature, as determined according to the steam tables, is known, as has been said, as the hygrometric state, yet this ratio is numerically equal to a number of other different ratios relating to the same phenomenon. Hence this state is often defined in a number of other ways which often enable it to be measured much more readily and satisfactorily than can be done by this procedure. Thus the pressure of a saturated vapor is a function of the temperature only, and is independent of the volume. Hence the amount of material present in a saturated vapor is proportional to its pressure. In the same way the pressure of an unsaturated vapor is proportional to the amount of material present, if the temperature and volume are kept constant. Hence the unsaturated pressure of a vapor is proportional to the amount present, and the hygrometric state reduces to a ratio of the pressures of the unsaturated and saturated vapors which are present or can exist under given indentical conditions.

This ratio of the pressures is equal numerically to the ratio of the weights and is known as the relative humidity or the hygrometric state, and with some instruments, designed for this purpose, is much simpler in its determination than is possible by a direct determination of the weights, even though one has been determined and is obtainable from the steam tables. Again, since the pressure of a saturated vapor is directly proportional to its temperature, and somewhat analogous conditions hold for unsaturated vapors, the ratio can be reduced to temperature variations, and we have the hygrometric state or relative humidity of a given air content as a simple funtion of its temperature and the temperature of its dew point, namely, that temperature to which the air must be lowered in order that water shall be condensed or dew produced readily.

Nearly all hygrometers, other than the chemical one, utilize this last relationship for the determination of the moisture content and relative humidity. They consist essentially of two thermometer bulbs, one of which records the temperature under given conditions, and the other is surrounded by some cooling agent whose temperature it records at the time when dew is produced or moisture has become perceptible in this form in the immediate vicinity. Thus the wet-and-dry bulb hygrometer consists simply of two thermometers, one of which has its bulb surrounded with an ordinary cotton wick which has its end immersed in a tube of water. The capillary action keeps the wick moist, and the evaporation into the air produces the cooling effect which is at once perceptible in the reading of the thermometer.

The scale used with this device is a purely arbitrary one, determined through calibration with a chemical hygrometer or dew-point measuring device, but gives fairly satisfactory and accurate results of the relative humidity.

The actual dew-point hygrometer, so-called, consists of two thermometers, one for the registering of the atmospheric temperature and the other for the determination of the dew-point. This latter thermometer is surrounded by another bulb, into which ether or some other volatile liquid can be poured and rapidly evaporated by passing air through it by means of blowing or by the action of an ordinary water aspirator. This bulb containing the ether is partially covered by a polished metallic surface, and when the cooling effect produced by the evaporation of the ether has continued a sufficient time, this surface will become covered with moisture, due to the condensation of the water vapor present in the air, and the temperature at which this occurs is recorded by the thermometer, which gives the temperature of the boiling or evaporating ether. This device is much more satisfactory than any of the arbitrary calibrated ones.

The amount of water vapor present under ordinary conditions is comparatively small, being, approximately, 5.85 grains per cubic foot as an average for a five days' test at the installation of the refrigerating plant for the removal of moisture from the blast in iron furnace operation at the Isabella furnace of the Carnegie Steel Company at Aetna, Pa. This represents approximately normal values; which vary however, from one grain to as high as eight or more, and even considerably larger values represent fairly average conditions in the tropics. The eastern sea coast of the United States represents a much greater hygrometric average than is present in the Middle West, and this latter bears almost an equal ratio to Rocky Mountain conditions. In the installation mentioned, each grain of moisture content per cubic foot meant a water removal of 40 gallons per hour, so that the effect, in the aggregate, is by no means neglible.

In addition to its effect in blast-furnice operation and internal-combustion motors and air compression, its significance in cooling towers and their operation is equally pronounced. A cooling tower on a dry day may readily cool steam condenser water of 160 degrees to 200 degrees F., to values as low as 70 degrees or 80 degrees F., whereas on a moist, warm day the fall in temperature may not exceed one-half to one-third of this.

The temperature of the air is, in reality, a matter of minor significance, and a number of tests are under consideration by cooling-tower manufacturers, undertaken with a view to the actual introduction of heated air into the cooling tower for the purpose of increasing effect on account of the increased possibilities in absorption of water vapor under these conditions. The fact that mechanical refrigeration has been proved to be a most efficient device in the removal of the water present in the air, and the further fact that this mechanical refrigeration can often be produced by the utilization of exhaust steam, a commodity or by-product often wasted, represents a condition which permits of its development for this purpose with a comparatively high degree of efficiency. The situation is such that practically no engineer can afford to-day to be without this knowledge in regard to hygrometric conditions, and to have some conception of the effects of the presence of the moisture in the air upon any special process in which he is interested.—*Condensed from Cassier's Magazine.*

CONCLUSION OF CAISSON DISEASE DISCUSSION

Since the publication in our October issue, page 5431, of the discussion of the paper by Henry Japp upon Caisson Disease and its Prevention the conclusion of the discussion has come to hand, this being here reproduced, somewhat abridged, from the Proceedings of the American Society of Civil Engineers. It will be remembered that in Mr. Japp's paper he said that "Thus far, practically, no grandfatherly legislation hampers engineers in the United States," while in his conclusion of the discussion here given he speaks in commendation of a New York State law which had been enacted in the interim.

T. Kennard Thomson, M. Am. Soc. C. E.—The writer has read this valuable paper with much interest, and notes that the author does not refer to the old-fashioned remedy—the electric battery—probably because it is not nearly as reliable as recompression. The writer once cured himself of an attack of bends by electric shocks, after he had failed to get any relief from recompression; and the next time the battery failed to cure him and recompression did—and so it goes. He has had the bends after being under an air pressure of 23 lb., and was not affected by a pressure of 35 lb. on the same job. The purity of the atmosphere and the physical condition of the man at that particular time have much to do with the case.

The writer, *having no ear drums*, has never had much trouble in keeping his ears from getting blocked, and, as a rule, he has been affected much less by the air pressure in vertical caissons than in tunnels; this he ascribes partly to the fact that the air in caissons is renewed more frequently than in tunnels and therefore is fresher, and partly to the increased time he was obliged to remain in the tunnels to get to the headings.

Under the Harlem River, when under comparatively light pressure, while sinking through the foul river bottom, his men have been much troubled by the bends, but have experienced very little inconvenience under much greater pressure while the caissons were sinking through the clean clay below the river-bed.

In an emergency, the writer has seen men work for 18 or 20 hours in pressures up to 25 lb. without any ill effects. He has gone in and out of the caissons repeatedly for 86 hours (without going to bed), under pressures up to 35 lb., without inconvenience—but would never be guilty of such hours again.

Gauge pressure, in pounds.	Time under pressure.	Interval between spells.	Uniform decompression, in minutes.
0-28.......	8 hours, less interval......	30 consecutive minutes spent in the open air...........................	18⅔
28-35.99....	2 spells of 3 hours each...	At least 1 hour.	24
36-41.99....	2 spells of 2 hours each...	At least 2 hours......................	42
42-45.99....	2 spells of 1½ hours each.	At least 3 hours......................	46
46-49.99....	2 spells of 1 hour each....	4 hours...............................	50

No employee shall be permitted to work in pressures exceeding 50 lb. per sq in. except in cases of emergency.

The decompression shall be at the rate of 3 lb. every 2 min., unless the pressure shall be over 36 lb., in which event the decompression shall be at the rate of 1 lb. per min.

TABLE 5.

When he had the bends, the pain disappeared while he was in a perspiration induced by drinking hot coffee, only to return when he had cooled off. He then tried a very hot bath and felt well until he had dressed.

As stated by Mr. Japp, slow decompression is the best preventive known, and recompression is not always reliable. As the author also states, hot coffee should always be taken on coming out.

HENRY JAPP, M. AM. SOC. C. E.—The discussion, thus far, seems to indicate that the general opinion is that the cause of caisson disease is the presence of gas bubbles in the blood and tissues, the only one taking exception to this being Dr. Loomis, who states that bubbles have only been demonstrated under exceedingly high pressures—15 or 20 atmospheres.

The writer cannot agree to this as he has seen the results of three autopsies on men who have died on coming out of pressures between 30 and 35 lb. gauge, and in each case bubbles were plainly visible to the naked eye in the blood vessels; and he has read reports of many more, and in almost every case similar bubbles have been seen. In one case Drs. McWhorter and Erdman were able, at the autopsy, to collect and analyze the air which escaped from a large bubble in the heart. It may be thought that these bubbles are not present during the life of the subjects, but the writer has also seen what had every appearance of being little bubbles passing along in the blood vessels of the wrist of a member of the East River Tunnels staff about half an hour after he came out of the air pressure.

Dr. Loomis' extraordinary success, in having so few deaths as he mentions, is highly commendable, but there is no doubt that if a larger number of fatal cases had passed through his hands he would have made similar observations.

The fact that Dr. Leonard Hill has exhibited the formation of bubbles and the stoppage of the circulation in the web of a living frog by sudden decompression, and the disappearance of the bubbles and the resumption of the circulation by recompression, should of itself show that, although this was obtained by high pressures for the purpose of rapid demonstration to an audience, the same thing can readily occur with a lower pressure.

While Dr. Loomis does not accept the theory that bubbles of gas cause bends, he presents no alternative.

Dr. Haldane suggests that, as the conditions vary so widely in different kinds of work, it is undesirable to lay down by legislation or otherwise any hard-and-fast rules as to decompression, and in the paper the writer calls attention to the danger of legislation if it is not guided by the Profession. Since this paper was written, however, the New York State Legislature has enacted a law which limits everything. The hours of labor and the rates of decompression are according to Table 5.

This law is a great step in advance of anything attempted privately in the United States, and the Commissioner of Labor is to be congratulated, but if these rates are compared with the suggested Table 4 of the paper, it will be found that the new law proposes a greater degree of safety for the lower than for the higher pressures, and inasmuch as the law requires that the decompression shall be uniform, the final pressure in the blood on coming into the atmosphere will be much higher than would result from stage decompression. In order that this may be seen more clearly, the writer has calculated the pressure in the blood for the various pressures, decompressing uniformly as required by the law, and also by stage decompression, and gives the results in Table 6.

Tunnel pressure, in pounds (gauge).	Time worked, in hours.	Uniform decompression, in minutes.	Pressure in blood on emerging, in pounds.	Stage decompression, in minutes.	Pressure in blood on emerging, in pounds.
28	8	18⅔	25.70	14	25
36	3	24	30.25	36	25
41.99	2	42	31.25	37	25
45.99	1½	46	32.00	35	25
50	1	50	32.50	33	25

TABLE 6.

It will be noted that, whereas the stage decompression proposed fixes the pressure in the blood on emerging from the air-lock at a constant of 25 lbs. per sq. in., the uniform decompression periods required by the law give pressures in the blood on emerging varying from 25.70 up to 32.50 lb., such a result being obtained in the case of 50 lb. with 17 min. longer for uniform decompression than stage decompression, and when it is noted that, for a pressure as low as 9 lb. per sq. in., the law requires 2 min. for every 3 lb., or 6 min. for decompression, it will be seen how inconsistent are the requirements. In other words, the new law requires generally more time for uniform decompression than is needed for stage decompression, while giving less safety.

It is doubtful whether Dr. Keays is correct in stating that the body fluids are practically saturated at any given pressure in about 3 hours. Fig 4. (Compressed Air Mag. page 5404) shows that in 3 hours the slower saturated parts are only 81 per cent. saturated, but the writer is of the opinion that much could be done toward ascertaining the rate of saturation by further experiments.

With regard to Dr. Keays' remark on "delayed caisson disease" (that is, cases which occur many hours after decompression), and his deduction, from those which occurred after too rapid decompression, that the lengthening of the decompression to periods suggested by Dr. Haldane would not prevent all cases of illness, or even serious and fatal ones, this cannot be accepted as more than an expression of opinion, inasmuch as no cases had occurred in Dr. Hadlane's experience when his rules were adopted, and it is doubtful if any delayed cases would occur or would have occurred had Dr. Haldane's rules been adopted, as the sole object of slow-stage decompression is to prevent the formation of injurious bubbles.

Delayed caisson disease after too rapid decompression can be explained by the accumulation of gas in tissues, which, though strong enough to stand the pressure of the accumulated gas for some hours, ultimately break down under the strain. Liberated gas collected in pockets cannot very readily be absorbed again excepting by recompression.

Mr. Saunders' description of the effects of recompression and decompression in his own case, when he was paralyzed, is an excellent illustration of the bubble theory.

Dr. Erdman's idea of the lungs acting as an escape valve is very ingenious, and is quite in line with the general mechanical theory of caisson disease. An investigation on the lines of his suggestion would be very valuable.

Mr. Aims' reference to the effect of dissipation on the resistance of men to the effects of compressed air and to the effect of the general comfort of the men coming out of the air-lock is generally accepted as important, but with slow decompression the discomforts of fog and cold are not felt in air-locks, and therefore heating is not as important as in the case of more rapid decompression.

Dr. Loomis' suggestion that the weather changes play a very great part in the causation of disease is not borne out by observations made by the medical staff on the East River Tunnels.

Mr. T. Kennard Thomson's remarks are valuable, coming from a man with so much actual experience in air pressure, and his acceptance of slow decompression as being the best preventive known—coming as it does from an engineer, the bulk of whose experience has been in caissons with small air-locks, where slow decompression is not an easy matter—leads one to hope that, even under such disadvantages, practical men will ultimately arrange for a slow decompression.

The reason why recompression is not always reliable, as Mr. Thomson says, is that the bubbles having torn the tissues and done the damage, no amount of recompression which merely removes the bubbles will heal the torn tissue, but if recompression can be resorted to promptly, before any permanent injury is done, then relief will be obtained.

THE SMOKELESS BURNING OF COAL

At the experimental station of the United States Geological Survey at Pittsburg it is claimed that a workable solution of the problem of smokeless coal combustion has been found. The plant in that city of smoke is being operated absolutely without smoke, in spite of the fact that it is using coal considered refuse by the trade and costing only 88 cents per ton delivered at the station. The secret of the success lies in perfect and complete combustion before the gases strike the chilling surfaces of the boiler.

The statement is made in this connection that "in 50 per cent. of the industrial plants of the United States more than 10 per cent. of the coal bill can be saved each year by the smokeless burning of coal." The trouble has been to contrive practical arrangements that would make smoke consumption, or rather smoke avoidance, an actual economy to the man who pays the bills; "and until that is done," says the *N. Y. State Board of Health Bulletin* "the esthetic loss of a sunless, smoke laden atmosphere, the monetary loss in the deterioration in smoke begrimed commodities and the unquestionable physical loss in the deleterious effects of smoke upon the health seem fated to continue on unchanged.

ACIDS

Acid is a general term used in chemistry, and is applied to a group of compound substances possessing certain very distinct characteristics. All acids have one essential property, viz.: that of combining chemically with an alkali or base, forming a new compound, which has neither acid nor alkaline character. New bodies formed in that manner are called salts. Every acid is therefore capable of producing as many salts as there are basic substances to be neutralized, and this salt-forming power is the best definition of an acid substance. Most acids when applied to the tongue have a very sour taste. Blue litmus paper is turned red, and if the colors on fibres have been turned green by the action of an alkali, the acid will, as a rule, restore them to the original state. Another method of regarding an acid, which is found of great importance in discussing chemical reaction, is to say that an acid is a salt whose base is water. This definition is very apparent if we regard what takes place in separating the acid from a salt. In this decomposition the acid would appear to be left without having any substitute to take the place of the removed alkali. This is not the case, however, for water is found to enter into the union instead of the base. It can be readily see that every true acid must contain hydrogen; and if this is displaced by a metal, salts are formed directly. The acid can therefore be called a salt whose metal is hydrogen.

A NOVEL AIR PUMP AND VACUUM GAGE

BY THE BERLIN CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

The most indispensable auxiliary of the physicist intent upon investigating those mysterious radiations the study of which is becoming more and more important is doubtless the air pump. For that reason many scientists and engineers have endeavored to improve the existing types of air pumps and have designed novel systems. One of the most interesting is that invented by Dr. Von Reden, of Franzburg, near Hanover.

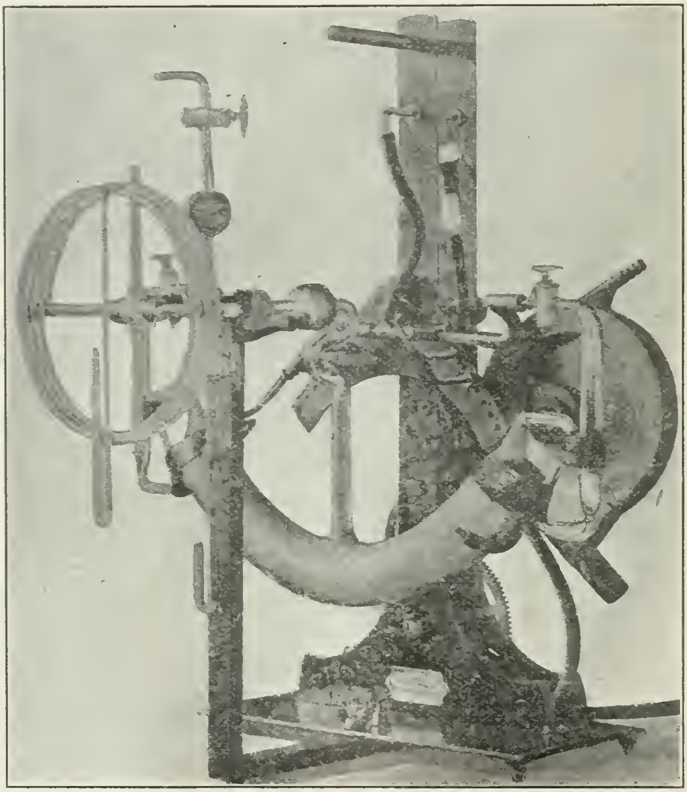


FIG. 1. VON REDEN VACUUM PUMP.

This is a mercury pump, the design of which will be most easily understood by reference to Figs. 5 and 6. The pump consists of a tube filled one-half with mercury, as indicated by the shaded portions. This tube is provided at its two ends with S-shaped tubes *B*, and at its middle with a straight tube *C*.. The S-shaped tubes are connected on both sides to widened portions *F*, connected by rubber tubing with a T-shaped tube and thence by tube *I* with a water supply *W*. The straight tube *C* and the bulb *D* to be exhausted are connected by a rubber tube *P*. The entire apparatus turns round a pivot *A*.

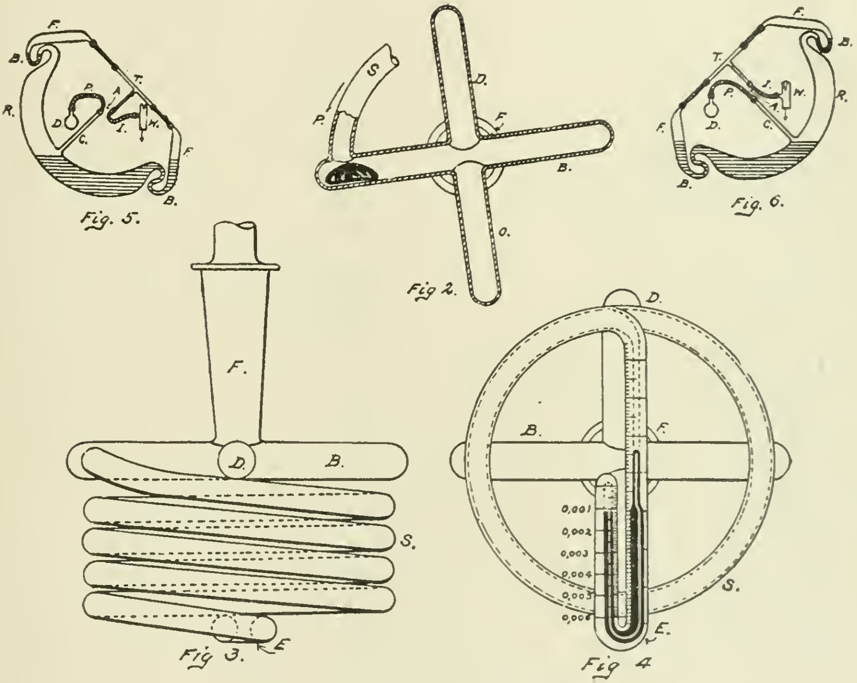
After having produced a preliminary vacuum (of about 20 millimeters of mercury) in the bulb *D*, and the apparatus, by means of the water pump *W*, the apparatus is oscillated from the position represented in Fig. 5 to that of Fig. 6 and back. The mercury remaining in the S-shaped tubes *B* acts as a pressure valve, and prevents the air in the enlarged portions *F* from returning to the tubes *R*. On the other hand, the air entering from the bulbs *D* in both positions through *C* is driven by the mercury toward the widened portions of the apparatus through the right-hand and the left-hand S-shaped tubes respectively, in order to be eventually discharged by the water pump. The connecting tube *P*, which, owing to its porosity, would not be very efficient, is advantageously replaced by a connection consisting of ground-glass joints in the shape of perforated glass balls, fitting tightly in the carefully polished hemispherical cap, as shown in a half-tone illustration, Fig. 1. In order to connect the ball with the cap, metallic springs may be employed.

Fig. 1 represents to the right a turbine belted to a pulley, which oscillates the tube by means of gearing and a crank mechanism. The glass ball joints lead to the spiral vacuum gage and the joint provides a connection with the bulb to be exhausted. A short-arm manometer is mounted below the bulb.

The pump above described can exhaust within three minutes a bulb of about 500 cubic centimeters capacity (a preliminary vacuum having been previously obtained by means of a water pump) to 1/100 of a millimeter of mercury; in four minutes, to 1/1000; in five minutes, to 1/10,000; and in thirteen minutes, to 1/100,000 millimeter of mercury, the lower handle being turned at the speed of six revolutions per minute. All the air should be expelled from the two vacua *F*, in order to obtain the vacuum last named. This is effected when the pump has been given its maximum inclination by means of the mercury, which on entering the apparatus throws back any residual air through the cocks *H* and *H'*, closed rapidly after the tube *R* has been kept oscillating for seven minutes. The pump is stopped only for a very short time.

The vacuum gage represented in Figs. 2, 3, and 4 consists of a spiral glass tube attached to two cross tubes (Fig. 2). The left-hand tube *B* incloses a small amount of mercury and the cross tubes *B*, *D*, *O* are mounted on a standard ground-glass joint, the conical angle of which is accurately given.

By turning the spiral round on the axis of the joint *G* in the direction of the arrow *P* (Fig. 2) the small amount of mercury represented at the left of Fig. 2 is made to enter the spiral, there compressing the exhausted air, until after a number of revolutions it enters the U-shaped tube *E* of Fig. 4, in order there to occupy the position marked. The left-hand arm of the U-tube is so graduated that the di-



DETAILS OF VON REDEN VACUUM PUMP.

visions 0.001, 0.002, etc., to 0.006, limit 1/1000, 2/1000, etc., to 6/1000 of the total capacity of the U-shaped tube and of the spiral in the upper portion of the capillary tube. The right arm of the U-shaped tube is graduated to millimeters. In the present case, the exhausted air of the spiral is compressed as far as the division 0.001; that is, to 1/1000 of its previous volume; in the right arm of the tube, the mercury takes up a position 16 millimeters higher As, however, the atmospheric pressure in the bulb to be exhausted is 1/1000 of the pressure read on the gage, its value has accurately been 16/1000 millimeter.

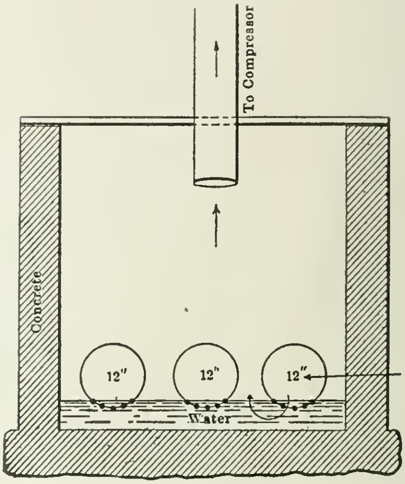
The spiral gage will indicate vacua up to 1/10,000 millimeter. The only distinctive feature of the one used in measuring a vacuum of 1/100,000 millimeter is its being provided with a longer spiral and thinner U-shaped tube.

ATMOSPHERIC HUMIDITY A FACTOR IN EGG PRESERVATION

Notwithstanding the enormous number of eggs consumed in New York it is seldom that an actually "bad" egg is found. The "goodness" of the eggs, however, is a vastly variable quality. The age of the eggs sold may vary from a day to a year, and age tells against them. The "meat" of the egg entirely fills the shell at the beginning, but when it is stored shrinkage by evaporation begins and the longer the egg is kept the smaller will be the bulk within. If an egg is boiled hard the extent of the shrinkage will be indicated by the vacant space usually in the larger end. The United States Department of Agriculture is investigating the various methods of preserving eggs for the purpose of determining which method is most efficacious and works the least injury to the eggs. It has been discovered that the amount of moisture in the air surrounding the egg is an important factor in egg preservation, for which reason the Department is conducting experiments to devise means for regulating the amount and the humidity of the air supplied to eggs kept in cold storage.

WASHING AIR FOR COMPRESSORS

The site of the compressor plant of the Penn Iron Mining Company is on a sandy bottom-land at the base of a hill that furnishes more or less sand during windy weather. As the result of these conditions sand would get into the compressors and cause trouble. A scheme for washing the air was resorted to which is shown in the accompanying sketch. A concrete box 5 1-2 ft. wide, 5 ft. high and 16 ft. long was constructed. In the bottom of the box three 12-in. cast iron pipes were laid, extending the full length of the box, their open ends outside the box. The pipe is supported by the end walls. The lower side of the pipe is perforated with a sufficient number of 1-2-in. holes to allow the air to pass down through the water and up into the box. Water is placed in the box so as to cover the perforations in the pipe 1 in. deep. This, however, is adjustable and can be arranged for any depth necessary.



CONCRETE BOX FOR WASHING AIR.

The box is covered tight with plank so that all the air must enter through the water-covered holes in the 12-in. pipe. The intake pipe from the compressor enters from the top of the box but does not extend to the water. L. F. Armstrong, mechanical engineer for the company, designed this apparatus.—*Engineering and Mining Journal.*

The National Fire Protection Association's Committee on Artificial Refrigeration recommends: That graphite be used as a lubricant in air compressors used in dense air systems and for air compression for purposes other than refrigeration, as the temperature of the compression cylinders undoubtedly rises in some air systems to a point where inflammable vapors may be generated from lubricating oil.

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FRANK RICHARDS, - - Managing Editor
L. I WIGHTMAN, - - - Business Manager
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THE INTAKE PRESSURE IN AIR COMPRESSOR CYLINDERS

We cannot undertake the stunt proposed below by our esteemed correspondent, except in so far as we have done it in the issue immediately proceeding this. It would be a good topic for an engineering student's graduating thesis or for a paper to be buried in the transactions of one of the societies, but on our pages it would be a waste of space, and to many of our readers the computations involved would be an exasperation. We have no monopoly of the theory of the inertia of the air causing the phenomenal filling of the air cylinder at the beginning of the compression stroke. This excess of pressure is attested by indicator cards from compressors of several different types. We think the "ram" theory is a little better than to attribute the occurrence to the heating of the air as it flows into the cylinder or to say that leaky discharge valves or pistons do the trick. We do not know any one in the United States more likely to be able to offer a still better explanation than our present correspondent.

Editor Compressed Air Magazine:

Referring to the article on page 5441 of the October issue of Compressed Air Magazine, I note your remarks concerning the ram effect of the intake air in piston inlet compressors [It is shown also by cards from compressors of other types. Ed. C. A. M.] and inasmuch as this same statement has appeared before in your publication, and has received your endorsement, I believe it would tend to help us all along to a proper recognition of the fact if you would go into the matter a little more in detail and with some figures attached. I would suggest:

First; that you assume a certain size of cylinder and a piston speed best adapted to illustrate your theory.

Second; that you assume some point in the intake stroke where this ram effect begins and thus be able to calculate the velocity of the air in the piston inlet [Why not any other kind of inlet pipe connected to any other compressor? Ed. C. A. M.]

Third; that inasmuch as the air within this piston inlet is the only air that gives the ram effect [Not so. A pipe leading to the actual piston inlet pipe, or a similar pipe leading to any other compressor should be included. Ed. C. A. M.], its weight and velocity being known, you will then be able to give a value to its kinetic energy in foot-pounds or decimals thereof.

Fourth; knowing the weight of air in the compressor cylinder, you will then be able to calculate to what pressure the foot-pounds of energy in the piston inlet will compress the air in the cylinder, and we will have a result in pounds, ounces, or decimals of either, and thus have something definite while it may not be exactly accurate, and we can then judge if such a result will be sufficient to be noticed by an indicator pencil.

I confess I am puzzled by the last four lines of the article referred to, and cannot see what the quick closing of a valve has to do with it. It would appear that the same effect must be produced when there is a valve there or not, although, of course, the excess pressure produced by the ram would be immediately lost with [We would say without. Ed. C. A. M.] a valve. I hope you will give us figures.

E. A. Rix.

San Francisco.

SEVENTY-FIVE YEARS OF ENGINE BUILDING

A beautifully printed and exceptionally handsome and artistic brochure of fifty pages tells in a most interesting way the story of the beginning, the growth and the present status of the well known steam and gas engine building firm, the C. & G. Cooper Company, Mt. Vernon, Ohio. It is a story of beginning at the beginning, and then of healthy and continuous enlargement and advancement until now the business ranks with that of the great engine building firms of the world, while the character of its product stands also in the foremost rank. The business was founded by Charles and Elias Cooper in 1833, it being first a foundry and a shop whose output was plows, carding machines and special power machinery. Its first engines were of the most primative type. The firm built some locomotives in the early fifties. The first Corliss engines built in the West were designed by this company and placed in service in 1869. Charles Cooper died in 1901 at the age of 92, having retired from active business several years before. The personnel of the company is now in the third generation and it is pleasant to note that the broad original policy continues. The owners manage the business and are in personal touch with both patrons and employees. The company has always shown a personal interest in its men. It has paid them 6 per cent. interest on savings left with it, assisting the men to acquire homes and to become, as so many of them are, permanent and useful citizens of the community. The business has been carried forward through successive periods of depression without interruption, the confidence and good will of patrons and of employees have been held, and the firm stands firmer and higher than ever before in its history.

HIGH PRESSURE GAS DISTRIBUTION

By G. A. Reichard.

Noticing the article on page 5306 in reference to a small high pressure gas distributing system, I would state that the high pressure distribution of gas has been used in this vicinity for some years and I herewith give you a short description of the high pressure gas distributing system of the Los Angeles Gas & Electric Corporation, whose predecessors, the Los Angeles Lighting Company, commenced the high pressure distribution of gas in 1901, installing at that time a horizontal duplex single stage belt-driven compressor with a capacity of about 50,000 cu. ft. per hour.

Since then this system has grown to large proportions, and at present their high pressure distributing lines comprise more than 128 miles of feeders and laterals operating under high pressure, distributing gas to the outlying portions of Los Angeles and to the Cities of Pasadena, Alhambra, Dolgeville and Hollywood.

The compressor station is independent of the main gas manufacturing plant and situated about 1,000 ft. from the same, near the large gas holders. There are four compressors having a total capacity of more than 900,000 cu. ft. per hour or more than 15,000 cu. ft. per minute, as follows.

One 24/42x34x60 Laidlaw-Dunn-Gordon Corliss cross compound non-condensing duplex compressor, with "Cincinnati" air valve gear, having two mechanically moved inlet valves in each head of both compressor cylinders. This machine develops more than 1200 H. P. when operating at its maximum capacity and has a displacement of about 550,000 cu. ft. per hour.

There is also one 25x24 Hall duplex belt-driven compressor belted to a 350 H. P. electric motor, having a displacement of about 150,000 cu. ft. per hour.

One 22x30 Ingersoll Rand horizontal duplex belt-driven compressor belted to a 350 H. P. electric motor, having a displacement of about 148,000 cu. ft. per hour.

One 16x18 Laidlaw-Dunn-Gordon duplex belt-driven compressor belted to a 125 H. P. tandem compound engine having a displacement of about 57,000 cu. ft. per hour.

These machines all have mechanically moved inlet valves. The gas is delivered to the compressors from large gas holders under a pressure of from 6 to 10 inches of water. The entire plant is designed for a working pressure of 60 lb., at which pressure it is operated when working at its maximum capacity. However, when the consumption is light the working pressure is from 25 to 50 lb.

This system is very satisfactory, permitting the manufacture of gas economically in large quantities under excellent conditions, in a large and well equipped central plant. The cost of compression based on actual operating periods and conditions, including operating and fixed charges, is said to be less than 1¾ cents per 1,000 cu. ft.

There are a number of other high pressure gas distributing systems on this Coast but this is the largest and most important that I know of and is operated in connection with the largest crude oil gas manufacturing plant in the world.

THE BELL HUMIDIFIER

In a paper before the National Association of Cotton Manufacturers, Mr. George V. S. Michaelis gave an account of the system of humidification developed by Dr. Louis Bell of Boston, Mr. S. H. Bunnell and others of the Griscom-Spencer Company of New York. The mechanical and sanitary effects of this system depend upon an adequate circulation of properly conditioned air in mill or factory. Warmed fresh air is forced into the mill room by a series of fans, and exhaust fans are used to remove the foul air. Drafts are avoided by a four-sided distribution from the fan outlets through greatly enlarged openings, so that the velocity of the air currents is materially reduced, although remaining adequate to secure a general circulation in the mill room. Heating by pipes is recommended as giving more uniformity than hot blast alone.

The Bell humidifier consists of a rectangular copper case containing 17 sheets of 20x38-in. moistened cloth spaced about 1 in. apart. Each cloth is hemmed at its upper and lower edges, the upper hem being slipped over a slotted brass pipe and the lower end slipped over a tension rod by which the cloth is stretched in position. Water is supplied to the humidifier by a small manifold pipe to which the 17 brass pipes supporting the cloths are connected. In summer cool water is used and the evaporation as well as the contact with the cold sheets tends to decrease the temperature in the mill room. In winter the water must be heated, which may be done by introducing steam into the supply mains, as the cooling effect upon the air otherwise becomes too great, the air after leaving the case being lowered in humidity considerably as it circulates to warmer parts in the room. As the pipes are surrounded by the hem of the cloth, it is impossible for the water to fall clear of the cloth and to be caught in the form of drops in the air current. At the lower edge of the casing there is a gutter formed on the interior walls, by which the drip from the edges of the cloths is caught and conducted out of the path of the air currents.

A disk fan is secured to one side of the casing at the extreme top and is driven either by an independent electric motor or by a light belt. Air is drawn from the mill room into the humidifier casing and forced down between the sheets of cloth, emerging from the bottom of the case, where it is deflected outward evenly on all sides of the machine by a drip pan a short distance below the casing.

THE COST OF THE INTAKE

The necessity of having the air brought to the compressor in a cool, dry, pure state, is not sufficiently appreciated by engineers. As an illustration of the effect of the disregard of this rule the case may be mentioned of a well-known Mexican mine at which otherwise the heads of departments were earnestly working to reduce the operating cost. In this mine an electrically-driven air compressor was erected near the collar of the interior shaft, at a considerable distance from the mouth of the tunnel. The air entering the compressor was, of course, that of the room at the collar of the shaft, heated and vitiated by contact with the workings in heavy sulphide ores below. At some 10 meters from the compressor are well-ventilated, dry and cool old workings, having a temperature of some 20 degrees below that of the compressor room. A drive of about 5 meters would have made a connection and the cool air so brought to the intake valve of the compressor would have produced an increase of 5 per cent. in efficiency. The annual operating costs of this compressor were: Power, $22,500; direct labor, $2,340; oil, repairs, etc., $564; a total of $25,400, on which an increase of 5 per cent. in efficiency would make a reduction of $1,270.

AIR CYLINDER LUBRICATION

From the valuable pamphlet recently issued by The Fidelity and Casualty Company of New York, on "The Prevention of Industrial Accidents," we reproduce the following relating to the methods, safe and otherwise, of lubricating air compressor cylinders:

Recent disastrous explosions in air-compressor systems present striking examples of the danger existing from the use of ordinary engine oil in the air-cylinders of air-compressors. Only a pure mineral oil, with a flash point as high as good lubricating qualities will permit, should be used. As little as possible of even the best oil should be used. *An excessive amount of oil should be kept out of the system.*

Numerous cylinder oils are compounded, and such oils are likely to produce a carbon that will stick the valves, and collect on the valve-faces and other parts of the cylinder and valve chambers, resulting in a danger condition.

Air-receivers are liable to explosion from accumulated oil deposits. Every receiver should be equipped with a pressure-gauge, a safety-valve, and proper drains, and all reservoirs and likely places of deposit in the air line should be thoroughly and frequently drained and cleaned. It is bad practice to have the inlet of an air compressor take from a hot or dusty room,—the air should be cool and as clean as possible.

The practice of throwing kerosene oil into the inlet of an air-compressor to clean it is an extremely dangerous one, and the cause of an explosion under such circumstances is not difficult to understand. Lubrication of the air-cylinder with soapsuds (preferably made of soft soap, about one part soap to fifteen parts water) for a few hours each week (or less frequently if the load is light), instead of oil, will help very materially in keeping the cylinder clean. The only danger from the use of soapsuds is rust, and this should be overcome by being careful to discard the soap and feed the cylinder with oil an hour or so before shutting down. The receiver blow-off should then be opened and the accumulation of oil and water drained off.

An air-compressor engine should not be controlled by the air pressure alone, as many are, but should be fitted with an auxiliary governor which will act as soon as the speed rises above a certain predetermined limit. This will prevent the engine from "racing," in case an accident to the tanks or piping causes a sudden lowering of the pressure. It is not necessary for an explosion to take place to produce a lowering of the pressure, as the giving way of a pipe, valve, or tank from any cause will have the same effect.

The steel used in the construction of air-receivers should be of the best quality and should have a tensile strength of from 55,000 to 62,000 pounds per square inch. The side seams should be double-riveted, or better still be butt-strapped. The heads should be dished. The larger sizes of receivers should be provided with man-holes.

THE QUESTION OF THE ELECTRIC DRIVE

During the last few years the question of the best method of driving cotton mills has been brought into prominence by the claims which electrical engineers have put forward for the electric drive. The advantages claimed for electricity have sometimes been demonstrated by comparing a brand new factory with electric driving with a more ancient one in which steam power alone is used. When the Special Committee of Inquiry of the Bradford Engineering Society was formed some two years ago to investigate and report on the subject, millowners felt that they would at last obtain some reliable information to guide them in future installations. The Committee appointed as its chairman Professor G. F. Charnock, and embraced a number of gentlemen of recognized ability, both in mechanical and electrical engineering. Its preliminary report, issued in October, will not encourage factory managers to scrap direct mechanical drives in favour of electric motors. The Committee decided first of all to carry out certain experiments, with the object of determining the actual cyclical variation occuring in prime movers and electric motors, and also in shafting and machinery driven by them. After exhaustive trials carried out in mills, in which various driving conditions existed, the Committee have come to the conclusion that "in good installations there is practically no difference in cyclical variation between mechanical and electrical transmission when measured at the end nearest the main drive." The report even pronounces further in favour of mechanical transmission, by stating that there is less loss in this case in modern mills of ordinary dimensions where the power is generated on site.—*The Engineer.*

COMPRESSED AIR INFORMATION

The following (with our italics) is the concluding paragraph of a three column article in a Western paper about air receivers:

It is seldom practical to "re-heat" air in mining. But after the air is dried, re-heating increases the expansion and efficiency, *and even raises the temperature* so that it prevents freezing, and where practical this is not intended to belittle the value or importance of re-heating.

SMOKE AND FOG IN CITIES

Increasing attention is being given in German cities to all questions connected with atmospheric conditions. The fact that sunshine lessens as population becomes more dense, and especially when the activity of industrial centres expands superficially and increases in intensity, has long been noted. An increasing tendency to fog has also been observed, and both are effects of the imperfect and incomplete combustion of coal. Modern industry pays toll for this in the injury to delicate fabrics, the general depreciation in the value of many articles of trade and household use, and the increased cost of cleansing. Since the battle is waged with growing energy against tuberculosis, physicians and students of social science feel that the problem of purer air for the dwellers in cities has become one of prime importance. Statistics have been collected for some time past, which demonstrate how little sunshine falls to the lot of the residents of industrial cities, even when the sun is unobscured by smoke particles. In no German city has the loss of sunshine due to fog yet equalled that of London, where the foggy days during the three months, December, January, and February, increased from eighteen to thirty-one during the last half of the past century.

NOTES

We frequently have inquiries concerning the raising and transportation of grain by compressed air. Specific information as to what is actually being done in this line will be welcome.

An aeroplane flight of 144 miles in 4 hrs. 6 min. 25 sec. was made at Mourmelon, France, on Nov. 3, by Henry Farman. This flight was in competition for the 1909 Michelin cup, which was won in 1908 by Wilbur Wright in a two hour flight, and is the best endurance record yet made.

A German medical journal describes five recent cases of inquiry inflicted upon the eyes by the rays of mercury vapor lamps. These cases, in connection with others previously reported, leave no room for doubt that the light of the mercury vapor lamps employed in therapeutics and for the illumination of factories and other buildings may injure the eyes, not only by causing conjunctivits (inflammation of the lining membrane of the eyeball) but also by producing paralysis of the retina.

Prof. E. A. Watson, of the University of Liverpool, describes an experimental investigation of the dielectric strength of air. The potential difference necessary to cause a spark to pass between two small metal spheres at various distances apart, in air, was carefully measured, at air pressures between one and fifteen atmospheres. At the latter pressure it was found that air will stand an electrical stress of 40,000 volts per millimetre, a fact which may soon find an application in apparatus where high insulation is required

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It is well understood that an ordinary suction pump can draw water from a depth of 34 feet at the most, in practice falling short of this. A French machinist has found that by running a small tube open to the atmosphere down into the well and entering the suction pipe with a tight joint, the end of this pipe being curved to point upward in the water, it is possible by working the pump rapidly to lift water as high as 65 feet. Both the speed of working and the air admission require to be carefully adjusted.

The McMillan Pump, Power & Mfg. Company proposes to build at Kansas City, Kan., a free workshop for inventors whose ideas are seen to possess merit. The building will be 75 x200 ft., two stories, constructed of cement. The second floor of the building will be set aside for inventors who take advantage of the offer. The idea originated with Milton McMillan, the president of the company, whose early history as an inventor had taught him that many good devices are lost to the world because their inventors are handicapped by lack of the necessary funds to produce them.

A Ladder Dredge capable of excavating to a depth of 46 ft. below water level in hard material has been built in England for use in the port improvements at Para, Brazil. The dredging engines required for the chain of buckets aggregate 600 hp. and are mounted near the top tumbler, with their gearing designed to act as directly as possible upon the buckets so as to increase the efficiency when working in the hard material. The shaft of the tumbler over which the buckets turn at the top is of solid steel, 19 1-2 in. in diameter. The dredger will operate in conjunction with large hopper barges.

Three employees of the Penn Iron and Coal Company, Canal Dover, O., were crushed to death in the cylinder of a 160-ton blowing engine. The inside of the cylinder was four feet in diameter and the men were working with their feet against the piston end. The piston was being held back by a brake against the 30-ton flywheel. Suddenly the brake slipped and the wheel, impelled by a many-ton counter-balancing weight on one side, turned over. The piston crushed the three men into a space three inches deep and four feet in diameter, between the piston and cylinder head.

An interesting thing in the mushroom line came to light recently when a giant specimen weighing over thirty pounds was found near Pittsburg by one of the professors in the Carnegie School. The mushroom was edible, it was found, and though it may not have been the growth of a night, it certainly grew in less than forty-eight hours, since a search of its locality made the day previous to that on which it was found disclosed no evidence of it. If mushroom growers could arrange to cultivate this particular species, more than one mushroom fortune might be the result.

That the submarine bell is valuable in preventing delay of ocean liners by fog has recently been proved in the case of the "Lucania" and the "Kaiser Wilhelm der Grosse." The former vessel, while approaching New York, was enabled to make the light vessel by submarine bell signals, these being her sole guide. The captain of the "Kaiser Wilhelm der Grosse" when on an eastern passage was shut in by dense fog near Fire Island light vessel. He was able to hear the submarine bell and direct his course accordingly, although he was twelve nautical miles distant from the signal station. At the same time the fog horn of the lightship was quite inaudible.

Since there is no tide in the Mediterranean, the inhabitants of Marseilles were greatly astonished on June 15th, when the water of the harbor began suddenly to oscillate, and continued in movement for a quarter of an hour. Some observers say that the first waves were about two and a half feet in height, but others put their height at half that amount. Many thought that the cause was an earthquake, but Mons. Louis Fabry, after a study of the phenomenon, ascribes it to a sudden increase of the barometric pressure of the air on the surface of the sea in the neighborhood of Marseilles. The puzzling question remains, What produced the sudden increase of barometric pressure?

The use of the sand blast for polishing metals is being superseded now by a blast of simple hot air. It is the velocity that gives the polishing power. The articles to be treated are placed in a basket in a centrifugal machine driven at a very high speed, and heated air is blown from a pipe through the basket. A high polish is thus produced very rapidly. Nickel-plated articles that have become tarnished are made bright in a few minutes. Wet metal, fresh from the bath, needs no preliminary drying, for the current of air dries and polishes at the same moment. It is only necessary to so pack the articles that the air reaches them on all sides.

In a gassy mine where it is considered dangerous to convey electric current to the coal face, the general power advocated in such cases is compressed air. This does not mean, however, that the compressors should be located on the surface, but rather that advantage should be taken of the cheapness and efficiency of electricity as a distributing agent, consequently installing the compressor plant at the shaft bottom, or as near the face as electric current can be safely conveyed.

A phonographic safe-lock has been invented which it is claimed can be opened only by the owner. Tests in the presence of experts seem to substantiate the inventor's claims. Instead of a knob on the door there is the mouthpiece of a telephone. A delicate needle is attached to the diaphragm, the end of the needle resting in a groove of a sound record made on a phonograph cylinder. The word which the safe is locked on is thus recorded, and the one who uttered it must repeat it before the safe will open. In the tests a dozen men tried to imitate the voice of the man who locked the safe, but the lock would respond only to the right man.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

OCTOBER 5.

935,634. PNEUMATIC HAMMER. WILLIAM BAXTER, Jr., Jersey City, N. J.

935,655. GASEOUS-FLUID COMPRESSOR. DAVID E. HAIRE, Philadelphia, Pa.

935,684. GASEOUS-FUEL-BURNER WELDING-TORCH. GILMAN PETERSON, Orfordville, Wis., and EUGENE M. BOURNONVILLE, Jersey City, N. J.

935,735. ACETYLENE-GAS BURNER. ARTHUR BRAY, Leeds, England.

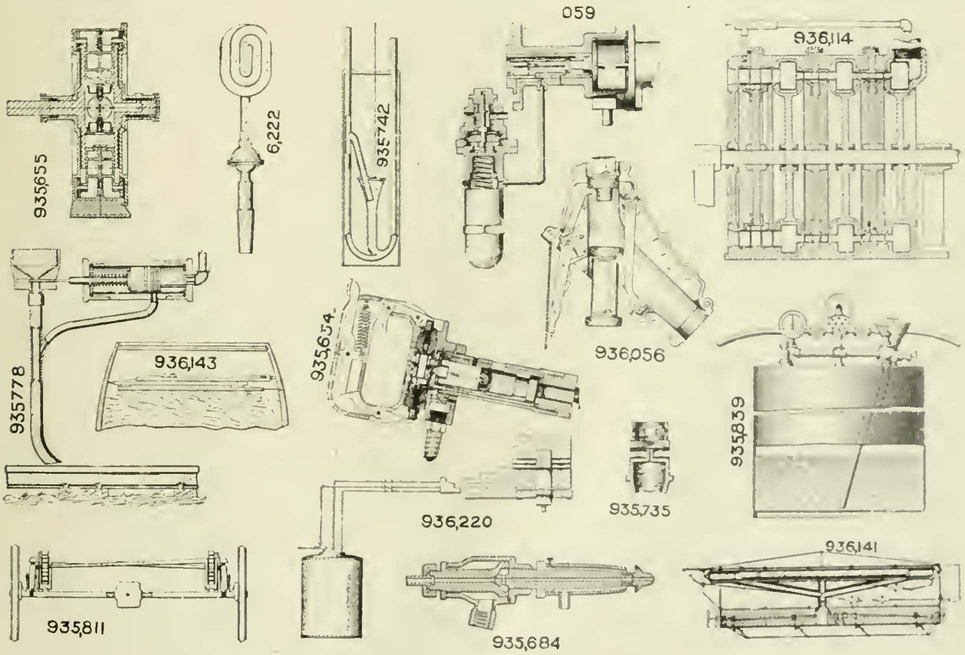
935,742. COMPRESSED-AIR WATER-ELEVATOR. HENRY E. CHLEBORAD, Atwood, Kans.

935,778. TRACK-SANDER. FRANK W. COLE, San Francisco, Cal.

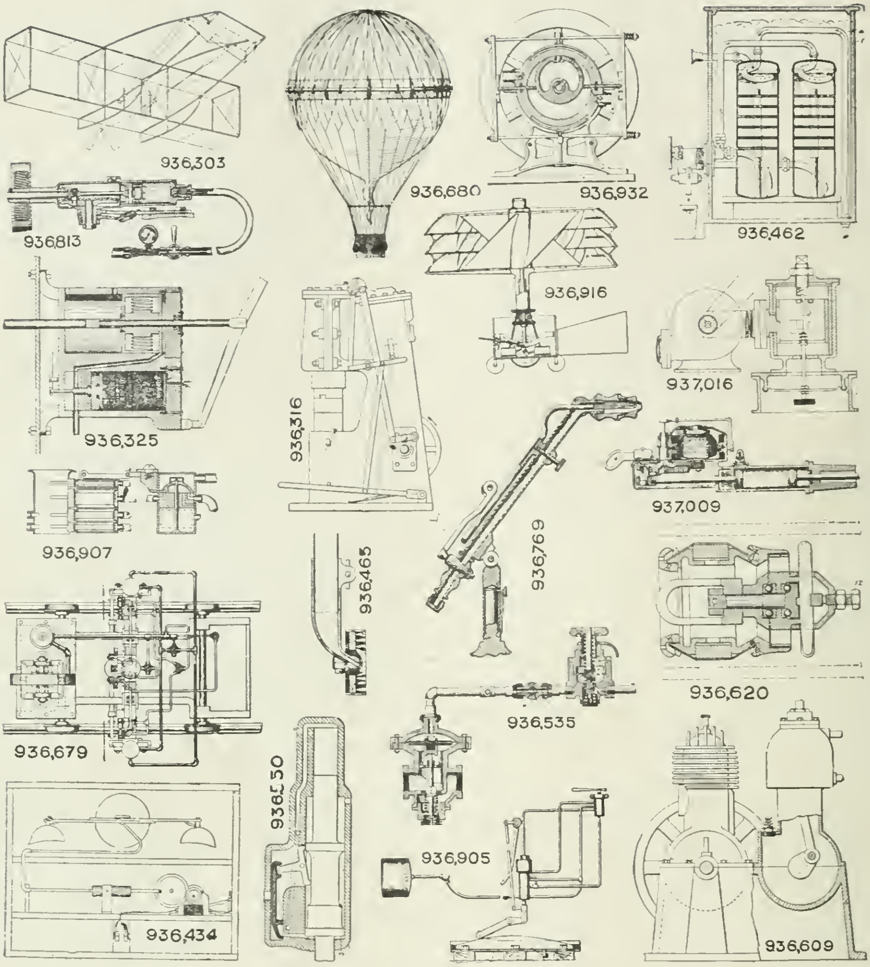
938,811. PNEUMATIC VEHICLE-GEAR. LOUIS J. PERKINS, Lewiston, Idaho.

935,839. EMBALMING APPARATUS. JUAN E. COPPOLA, Mexico, Mexico.

1. An apparatus of the class described, comprising a reservoir adapted to contain an embalming fluid, means for introducing compressed air into the upper part of said reservoir, a pipe leading from the lower part of said reservoir and adapted to lead off the embalming fluid, a valve for regulating the flow from said pipe, a plurality of trocars, and tubes connecting said trocars with said valve.



PNEUMATIC PATENTS OCTOBER 5.



PNEUMATIC PATENTS OCTOBER 12.

935,862. AEROPLANE. ALFRED W. REINOEHL, Philadelphia, Pa.

936,055. TROLLEY-GUARD. SAMUEL STROUP, Peru, Ind.

936,056. PNEUMATIC-DESPATCH APPARATUS. FRED R. TAISEY, Indianapolis, Ind.

936,114. AIR-COMPRESSOR. FREDERICK W. GARDNER, New London, N. H.

936,141. AIR-SHIP. ADOLPH E. G. LUBKE, San Francisco, Cal.

936,143. COMPRESSOR. WILLIAM H. MILLER, Independence, Mo.

936,222. PNEUMATIC CLEANING-TOOL. CHARLES B. DALZELL, Little Falls, N. Y.

936,220. WELDING OIL-BURNER. BREWSTER W. CRIBB, Baltimore, Md.

OCTOBER 12.

936,303. AEROPLANE. CHARLES W. CHENEY, Brookline, Mass.

936,316. PNEUMATIC HAMMER. WILLIAM GRAHAM, Westminster, London, England.

1. A pneumatic hammer having in combination a tup and tup chamber, a reciprocating pump working in a separate pump chamber, connecting means between said pump and tup chambers, means for closing said connecting means, and means acting automatically to cause a lag between said pump and tup pistons after a blow has been struck until the pump piston has moved outward a predetermined portion of its stroke.

936,325. MEANS FOR CONTROLLING THE MOVEMENT OF RAILWAY-VEHICLES. JOHN H. JUST, Syracuse, N. Y.

936,415. AIR-BRAKE SYSTEM. GEORGE E. CONGDON, Jacksonville, N. Y.

936,434. BUST-DEVELOPER. JOHN G. EGANHOUSE, Houston, Tex.

936,462. APPARATUS FOR DISPENSING GAS-IMPREGNATED LIQUIDS. MORRIS J. LEVIN, Providence, R. I.

936,465. VACUUM-SWEEPER. FRANK J. MATCHETTE and CHARLES MOUKOS, Milwaukee, Wis.

936,535. AIR-CONTROL STEAM-VALVE. JAMES A. HICKS, Atlanta, Ga.

936,550. PERCUSSIVE MACHINE AND TOOL. WILHELM MAUSS, Brakpan, Transvaal.

936,609. AIR-COMPRESSOR. Joseph H. Dailey, Wilson, N. Y.

936,620. TUBE-CLEANING APPARATUS. Johann G. Frerichs, Hanover, Germany.

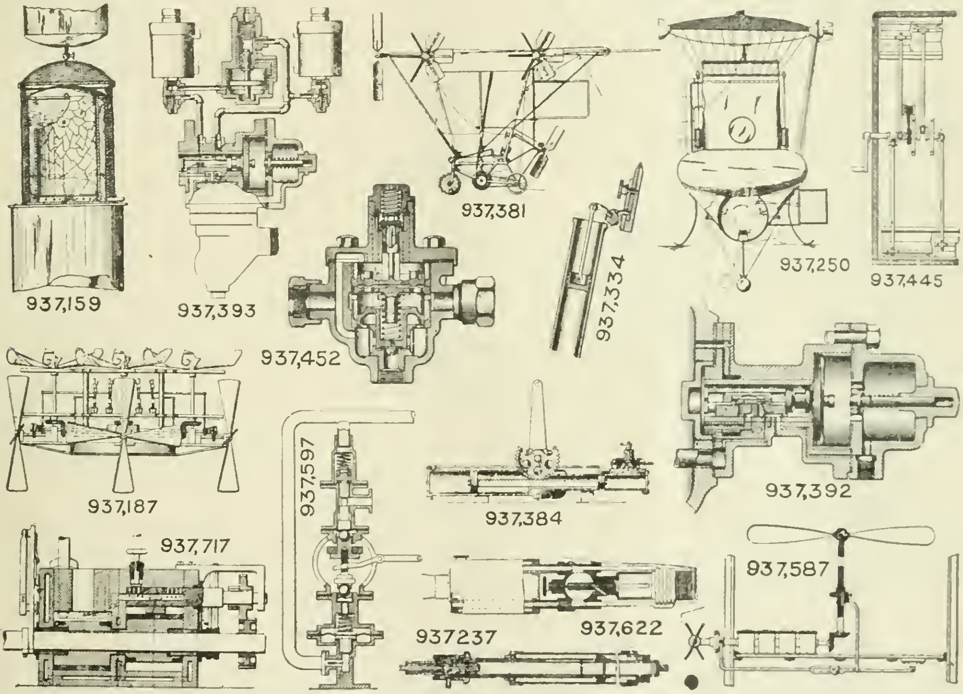
936,679. TRACK-LAYING APPARATUS. Richard C. Spandau, Danville, Ill.,

1. In a track-laying apparatus, a support, a pneumatically-operated hammer movable bodily up and down upon said support, pneumatic means for operating said hammer, and means for simultaneously lowering said hammer bodily so that the hammer will follow a spike during the driving operation to keep the hammer in position for driving the spike, substantially as set forth.

936,680. BALLOON. Joseph A. Steinmetz, Philadelphia, Pa.

936,710. FOLDING MECHANISM. Samuel G. Goss, Chicago, Ill.

1. The combination with folding rolls, a moving carrier adapted to engage a sheet of paper and forward it into folding position with reference to said folding rolls, and a compressed air supply, of a discharge pipe mounted on said carrier and adapted to discharge a sheet of air between said folding rolls, connections between said discharge pipe and said compressed air supply, and automatically-operating valve mechanism adapted to open the connections to said discharge pipe when said sheet is in position to be folded and then to automatically close said connections..



Pneumatic Patents October 19.

936,711. PNEUMATIC FOLDING MECHANISM FOR PRINTING-PRESSES. Samuel G. Goss, Chicago, Ill.

936,769. BLOWPIPE. James H. Flower, Ashtabula, Ohio.

936,813. AIR-COMPRESSOR. Edward J. Rohrbacher, Blaine, Wash.

936,905. AUTOMATIC BRAKE-APPLYING DEVICE. Earl P. Jessop, U. S. Navy.

936,907. MILKING-MACHINE. Gustaf E. Jonson, Hjerpas, Sweden.

936,916. PROPELLER MECHANISM FOR AIRSHIPS. Charles M. Lee, Gibbon, Nebr.

936,932. AIR-COMPRESSOR. Arthur Neumann, St. Louis, Mo.

937,009. PRESSURE-DRIVEN RECIPROCATING TOOL. Alexander Palmros, Syracuse, N. Y.

937,016. MECHANISM FOR THE PRODUCTION OF A CONSTANT MIXTURE OF GAS AND AIR. Friedrich W. Wolff, Berlin, Germany.

OCTOBER 19.

937,159. AERATOR. Lena E. Leach, Venice, Cal.

937,187. AIR SHIP. Benjamin F. Seymour, Denver, Colo.

937,237. ROCK-DRILLING MACHINE. James E. H. Grose, Germiston, Transvaal.

937,250. AERIAL NAVIGATION. Jeremiah S. Letts, Dickinson, N. D.

937,334. PNEUMATIC CLIPPER. Charles Shurtleff, Akron, Ohio.

937,381. MOTOR-DRIVEN AEROPLANE. August E. Mueller, Chicago, Ill.

937,384. FLUID-PRESSURE MOTOR. John E. Osmer, Chicago, Ill.

937,392. FLUID-PRESSURE BRAKE. Walter V. Turner, Wilkinsburg, and John S. Custer, Pittsburg, Pa.

937,393. ELECTRIC FLUID - PRESSURE BRAKE. Walter V. Turner, Wilkinsburg and Robert H. Blackall, Edgewood Park, Pa.

937,445. PNEUMATIC MUSICAL INSTRUMENT. Eugene de Kleist, North Tonawanda, N. Y.

937,452. AIR-BRAKE SYSTEM. George Macloskie, Schenectady, N. Y.

937,587. AEROPLANE. David S. Foster, Syracuse, N. Y.

937,597. SAFETY-VALVE FOR STEAM, COMPRESSED AIR OR GAS. Georg Grussendorf, Hanover, Germany.

937,622. BLOW-TORCH AND SOLDERING-IRON. Frank J. Mann, New York, N. Y.

937,717. INTERNAL-COMBUSTION AND AIR-

COMPRESSING ENGINE. WARD RISLEY, Jacksboro, Tex.

937,721. FLUID-PRESSURE REGULATOR. EDUARD SCHULTE, Hamon, Westphalia, Germany.

OCTOBER 26.

937,757. AIR-PUMP FOR BLOW-TORCHES. OTTO BERNZ, Newark, N. J.

937,789. MILKING APPARATUS. EZRA E. GOOD, Waterloo, Iowa.

937,790. PUMP. CARL R. GREEN, Dayton, Ohio.

937,827. FRESH-AIR-SUPPLY DEVICE. FRANK S. LIPPITT, Cleveland, Ohio.

937,839. AIR-BRAKE. LORENZO E. MOREL, St. Hyacinthe, Quebec, Canada.

937,872. ROCK-DRILLING MACHINE OR ENGINE. LEWIS L. SCOTT, Joplin, Mo.

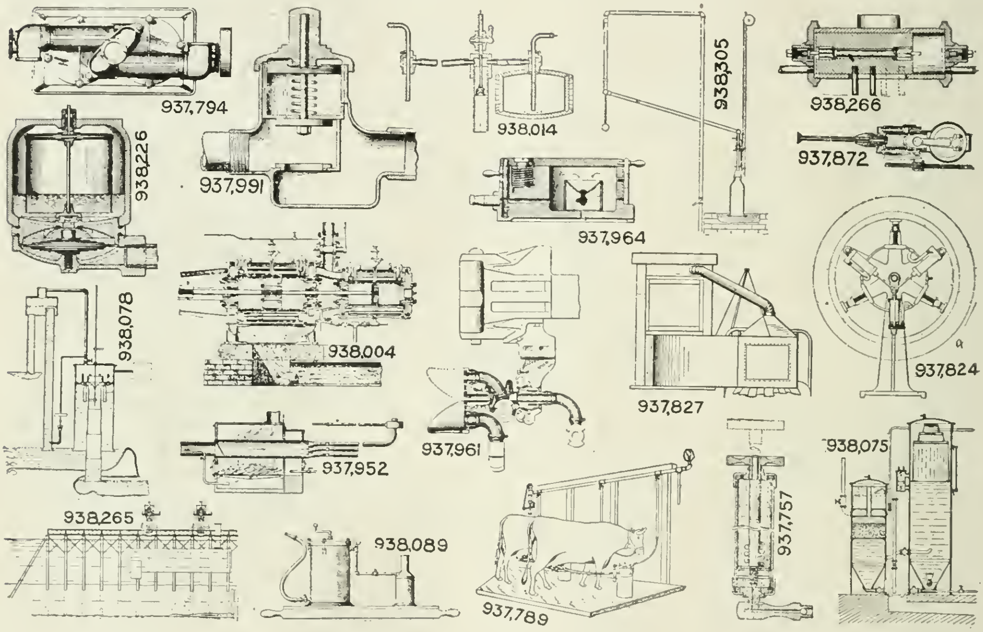
937,884. MEANS FOR HOLDING AND INFLATING PNEUMATIC TIRES. FREDERICK W. STANLEY, Grange-over-Sands, England.

938,014. PNEUMATIC SIPHONING SYSTEM FOR CIRCULATING AIR THROUGH BARRELS. JEREMIAH F. MCLAIN, St. Joseph, Mo.

938,075. WATER-PURIFYING APPARATUS. HANS REISERT, Cologne, Germany.

1. In a water elevator, in combination with a plurality of tanks provided with passages for the entrance thereinto of water by gravity, a pipe adapted to convey air under pressure into said tanks, a controlling valve adapted to shift the air into either of said tanks, and to simultaneously provide an exhaust outlet from another of said tanks, an air driven valve actuator adapted to shift said controlling valve, said valve actuator being provided with an air driven piston and a pilot valve carried by said piston adapted to control a discharge passage for the air used to drive said piston, substantially as described.

938,078. APPARATUS FOR ELEVATING WATER. OLAF A. ROED, Minneapolis, Minn.



PNEUMATIC PATENTS OCTOBER 26.

937,952. MEANS FOR OVERCOMING FROST. HARLEY A. HARDINGE, Los Gatos, and EDWARD A. PAGEL, Campbell, Cal.

The combination of a stationary furnace, an air tube leading therethrough, a plurality of nozzles, a blower for each nozzle, a connection from said air tube to each blower, independent valves for said connections, and an air supply tube for the furnace, the inlet end of said air supply tube being located within the inlet end of the air tube and pointing in the same direction, substantially as described.

937,961. AUTOMATIC AIR AND STEAM COUPLING. JOSEPH V. ROBINSON, Salem, Oreg.

937,964. MEANS FOR MAKING CASTINGS BY AIR-PRESSURE. ORRIN J. SAYERS, Cleveland, Ohio.

937,991. AIR-BRAKE SAFETY-VALVE. ORLANDO GIBSON, Hollidaysburg, Pa.

938,004. COMBINED AIR COMPRESSOR AND INTER-COOLER. JOHN G. LEYNER, Denver, Colo.

938,84. SPRAYING APPARATUS. ARTHUR G. STOUT, South Haven, Mich.

938,144. SPRAYER. EDWARD HARRY, Buffalo, N. Y.

938,226. VACUUM AIR-VALVE. CLAYTON A. DUNHAM, Marshalltown, Iowa.

938,265. SUBAQUEOUS TUNNEL. ERNEST W. MOIR, London, England.

938,266. WATER-ELEVATOR. JOHN MONTGOMERY, Toronto, Ontario, Canada.

3. In a water-purifying apparatus, the combination of a mixing chamber having a water-supply inlet and an air-inlet for supplying air thereto under pressure, means for converting the water into a finely-divided state, a settling-chamber connected with said mixing chamber and having an outlet therefrom, and an automatic regulator for decreasing the pressure when the water in the mixing chamber reaches a certain level.

938,305. AUTOMATIC AIR-VALVE MECHANISM FOR GLASS-DRAWING APPARATUS. HENRY DOUCHAMP, Smethport, Pa.

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